Dietary Practices, Maternal Nutritional Status and Child Stunting: Comparative and Intervention Studies in Pulse and Non-Pulse Growing Rural Communities in Ethiopia

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Abstract

Maternal and child undernutrition is a significant problem globally, particularly in low- and middle-income countries, such as Ethiopia. In 2008, Ethiopia began a National Nutrition Program (NNP) which prioritized maternal and child undernutrition. Ethiopia remains largely an agricultural economy; hence, improvements in the nutrition of women and children relies on agriculture (e.g. types of crops, productivity, consumption). Pulses are important crops, second to cereals; however, whether pulse agriculture translates to health benefits has not been well documented. This research aimed to document evidence of pulse agriculture translating to nutrition health benefits through: Characterizing the nutrition/food security situation and associated risk-factors of mothers and young children from both pulse and cereal growing communities; comparing the diets and health measures of mothers-children in pulse versus cereal communities; and, implementing a nutrition education intervention in a pulse growing rural community. Mixed method approaches, both quantitative and qualitative, were used in cross-sectional and intervention designs. Participants were mothers and their <5y of age children from two rural pulse-growing communities of Halaba and one cereal growing community from Zeway, Ethiopia. Data gathered included socioeconomic and demographic, household food security, dietary and anthropometric information using a semi-structured survey questionnaire, weighed food records, and anthropometric measurements. A six-month nutrition education program, involving interactive monthly community meetings and home-visits, was offered to one of the pulse communities and the other served as a control. Focus group discussions (FGD) were also conducted with male farmers to obtain their perspective on issues surrounding pulses. Very high levels of stunting among children <5y of age (54% in Halaba, 42% in Zeway) were found, as well as moderate to high levels of maternal undernutrition in Zeway (14%) and Halaba (22%) communities, respectively. Gender and household structure variables such as empowerment imbalance, access to land by women, household size and physiological density associated with maternal and or child stunting. In addition, many of the World Health Organization recommended infant and young child feeding (IYCF) practices were suboptimal, especially where complementary foods were below the estimated needs for energy and nutrients. The study also found unacceptably high levels of household food insecurity and hunger, particularly in Halaba communities with supply related factors (i.e., women's access to land, work burden, land size, frequency of production) having greater influence than demand factors. Median energy and nutrient intakes for mothers, but not children, were significantly higher in the pulse communities than those in the cereal community. Dietary Diversity Scores (DDS) were low (3 food groups) in both mothers and children independent of the communities studied. Pulse consumption was low in both communities. Child stunting and underweight, and maternal undernutrition were worse in the pulse than cereal communities. Pulses were mostly sold for income and women had limited control over use (e.g. consumption) and knowledge of the nutrition benefits of pulses was lower among mothers in pulse-growing communities. The intervention study in the pulse communities showed significant improvements in the intervention group for knowledge, attitudes and practice (KAP) of pulses among mothers. The median DDS, as well as pulse and animal source food consumption indexes, improved for both mothers and children. The mean body-mass index-for-age z-score increased and wasting decreased in the children. Farmers in the FGD expressed intention to produce and retain more pulses for home consumption. No such changes were found in the comparison community. Overall, this research showed high levels of child stunting and maternal undernutrition, suboptimal IYCF practices, and high household food insecurity and hunger which all indicate the need to strengthen government's nutrition service delivery to women and children. Mothers-children in the pulse communities did not have better nutrition status indicating pulse production does not necessarily translate to nutrition benefits unless bridging efforts, such as providing nutrition education, addressing gender disparities in access/control of resources (e.g. land, pulses) are in place. Community-based nutrition education interventions could be effective in improving mothers' knowledge of pulses and consumption frequency. Such interventions can lead to increasing DDS in mothers and their children, and decreasing underweight and wasting in rural Ethiopia.

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Published and submitted materials

Modified versions of the various sections in this thesis have been published as an abstract or journal article (or submitted for publication) and have been or will be shared as poster or oral presentations.

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Lombamo, G. E., Henry, C. J., & Zello, G. A. (2013, June 24-27). *Maternal and child anthropometry depicts high levels of chronic energy deficiency & child stunting in pulse growing communities: The case of Halaba Woreda, south Ethiopia (Poster abstract).* Presented at the Revised National Nutrition Program Launch Workshop, Addis Ababa, Ethiopia.

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Modified versions of chapter 5 (Study 2) have been published and presented at conference:

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Ersino, G., Henry, C.J., Zello, G.A. (2014, May 2-3). *Suboptimal feeding practices and high levels of undernutrition among infant and young children from pulse-growing communities of rural Halaba*, *South Ethiopia*; Invited conference presentation at the 3rd

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Chapter 6 (Study 3) has been shared in oral presentation at a conference and also submitted for publication:

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Ersino, G., Zello, G. A., Henry, C. J., & Regassa, N. (2016). Household Food Insecurity and Hunger in Selected Ethiopian Agricultural Communities: Examination of Supply and Demand Factors *(submitted for consideration in Ecology of Food and Nutrition)*.

A modification of Chapter 7 (Study 4) has been shared and published as a conference abstract at *Global Micronutrient Forum 2014*, June 2-6, 2014 Addis Ababa, Ethiopia and also a manuscript has been submitted for consideration in *BMC Nutrition*:

Lombamo, G. E., Henry, C. J., & Zello, G. A. (2015). Dietary Intakes of Fe, Zn and Protein and Anthropometric Measures of Mothers and Children Living in Pulse or Cereal-Growing Rural Communities of Ethiopia (Conference Abstract). *European Journal of Nutrition & Food Safety, 5*(5). doi:10.9734/EJNFS/2015/21221

Ersino, G., Henry, C. J. & Zello, G. A. Higher maternal and child undernutrition in pulse than cereal growing rural communities of Ethiopia: A comparative cross-sectional study *(submitted to BMC Nutrition, December 2016).*

Chapter 8 (Study 5) has been accepted for poster/abstract presentation at the upcoming 2016 Micronutrient Forum Global Conference:

Ersino, G., Henry, C. J., & Zell, G. A. (2016). *A nutrition education intervention affects the diet-health related practices and nutritional status of mothers and children in a pulse-growing community in Halaba, south Ethiopia (Conference abstract)* accepted for poster presentation at the Micronutrient Forum Global Conference 2016: Positioning Women's Nutrition at the Centre of Sustainable Development, October 24-28, Cancun, Mexico

Supporting results in Appendix D have been presented as a poster abstract:

Ersino, G., Zello, G. A., & Henry, C. J. (2015, March 13,). *Application of the Health Belief Model to understand the behavior of mothers in pulse or cereal-growing rural communities in Ethiopia (poster Abstract and 1st place poster award).* Paper presented at the 22nd Annual Life and Health Science Research Day, University of Saskatchewan, Saskatoon, Canada.

Table of Contents

Abbreviations and Acronyms

ANC	Antenatal Care
BMI	Body Mass Index
CDC	Centers for Disease Control and Prevention
CSA	Central Statistical Authority (of Ethiopia)
DALY	Disability Adjusted Life Years
DDS	Dietary Diversity Score
DHS	Demographic and Health Survey
EDHS	Ethiopian Demographic and Health Survey
EHNRI	Ethiopian Health Nutrition Research Institute
FANTA	Food and Nutrition Technical Assistant
FAO	Food and Agriculture Organization of the United Nations
FDRE	Federal Democratic Republic of Ethiopia
FEWS-NET	Famine Early Warning Systems Network
FFQ	Food Frequency Questionnaire
GDP	Gross Domestic Product
GNI	Gross National Income
HAZ	Height for Age Z-score
HBM	Health Belief Model
HC	Head Circumference
h	hour (s)
HDI	Human Development Index
HEP	Health Extension Program
HEW	Health Extension Worker
HFIAS	Household Food Insecurity Access Scale
HHS	Household Hunger Scale
HSDP	Health Sector Development Plan
HWZ	Height for Weight Z-score
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institutes

IMR	Infant Mortality Rate
IUGR	Intra Uterine Growth Restriction
IZiNCG	International Zinc Nutrition Consultative Group
LBW	Low Birth Weight
MDG	Millennium Development Goals
MMR	Maternal Mortality Rate
MUAC	Mid-Upper Arm Circumference
NCHS	National Centre for Health Statistics
NEAC	Nutrition Education and Communication
NEPAD	New Partnership for Africa's Development
NNP	National Nutrition Program
NNS	National Nutrition Strategy
PASDEP	Plan for Accelerated and Sustained Development to End Poverty
PSNP	Productive Safety Net Program
RCT	Randomized Control Trial
RNI	Recommended Nutrient Intake
SAP	Structural Adjustment Programs
SD	Standard Deviation
SNNPR	Southern Nations, Nationalities and People's Region
TFR	Total Fertility Rate
TLU	Tropical Livestock Unit
UN	United Nations
UNDP	United Nations Development Program
UNICEF	United Nations Children's Fund
UNU	United Nations' University
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WFP	World Food Program
WHO	World Health Organization
WHZ	Weight for Height Z-score
WMS	Welfare and Monitoring Survey

List of Tables

List of Figures

Chapter 1 Introduction

1.1. Background

Child growth can be an important marker of nutritional status and health of a population; it provides useful information on the quality of life or economic situation of populations, particularly in developing countries (African Union Commission, NEPAD Planning and Coordinating Agency, UN Economic Commission for Africa, & UN World Food Programme, 2014; Alderman & Berman, 2004). Childhood undernutrition has been reported as the largest contributor to the global burden of disease and death in recent years. The *Lancet* series on maternal and child undernutrition highlighted undernutrition as one of the leading risk factors to mortality and overall morbidity in children in low- and middle-income countries. This series reported that undernutrition was responsible for 3.5 million deaths in children under 5 years of age annually (Black et al., 2008; Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Black et al. (2008) also indicated that the collective contribution of stunting, severe wasting and intrauterine growth restriction (IUGR) to the overall mortality of under 5 children was one of the highest, with 2.2 million deaths per annum. Stunting, low height-for-age or shortness, is an indicator for chronic undernutrition, whereas wasting, low weight-for-height or thinness, indicates acute undernutrition (WHO, 2010). Although subsequent reports in the *Lancet* indicated some improvements five years after the initial review, undernutrition still accounted for up to 45% (3.1 million) of child deaths annually (Black et al., 2013).

Maternal undernutrition, a chronic energy deficiency expressed as a low Body Mass Index (BMI) of <18.5 Kgm^{-2} (WHO Expert Committee on Physical Status, 1995), is a known risk factor for IUGR associated low birth weigh and neonatal deaths (Black et al., 2008; Black et al., 2013; Kramer, 1987a). In addition to low BMI, maternal short-stature is also a manifestation of long term undernutrition and micronutrient deficiency; it increases the risk of caesarean delivery (i.e., obstetric complications due to a short pelvis) and maternal morbidity, even when safe and adequate medical services are accessible (Kramer, 1987b; Villar et al., 2006). This means maternal undernutrition poses significant public health challenge since most of the affected mothers live in low- and middle-income countries (Black et al., 2008) where access to such medical services is limited. Factors contributing to maternal undernutrition in less developed countries are many and complex, and include poor dietary intake (inadequate energy), food insecurity, work burden and gender disparity as well as other socio-economic and demographic factors.

It is important to note that about 80% (4/5) of all undernourished children live in only 20 countries in four regions of the world, namely Africa, Asia, the Middle-East and the Western Pacific (Horton, 2008). Sub-Saharan Africa, where progress in reduction of undernutrition has been the slowest (UN Standing Committee on Nutrition, 2011; UNICEF, WHO, & World Bank, 2015), is home for over half of all deaths—and with the highest rate of mortality—in children under-five years globally (Rajaratnam et al., 2010; UN, 2015). A United Nations International Children's Emergency Fund (UNICEF) report specifically identified the Eastern Africa region as home for the highest proportion of stunted children (UNICEF, 2009). Based on rates of under-five mortality and overall undernutrition, Ethiopia has been identified among the top countries needing priority attention (Horton, 2008; UNICEF, 2009). Despite progress made, children's nutritional health remains critical in Ethiopia, needing intensive and sustained political commitment if the country is to be positioned to meet the 'zero hunger' goal of the new Sustainable Development Goals by 2030 (United Nations, 2016) or the global challenge of reducing current level stunting by 40% by 2025 (1000 Days, 2015; WHO, 2014).

1.2. Problem Statement

Chronic undernutrition still remains a critical problem for young children, particularly in sub-Saharan Africa where rates of stunting and underweight have not shown significant progress in the last 20 years (UN Standing Committee on Nutrition, 2011). Ethiopia is located in the horn of Africa and is the second most populous nation following Nigeria (Central Intelligence Agency, 2015). According to a UNICEF (2009) report, Ethiopia had one of the highest rates of stunting with an estimated 6.7 million stunted children under the age of five. In 2013, Ethiopia was also among the 37 countries globally where 85% of the 162 million stunted children were concentrated (1000 Days, 2015). According to a recent Ethiopian Demographic and Health Survey (EDHS), prevalence rates of stunting, wasting and underweight remained high at 44.4 %, 9.7% and 28.7%, respectively, despite improvements made in the last two decades (CSA & ICF International, 2012).

In the 2008 *Lancet* series report, Ethiopia had one of the highest rates (27%) of maternal undernutrition in Africa following Eritrea (Black et al., 2008). It is worthwhile to note that the three EDHS surveys, conducted in 2000, 2005 & 2011, consistently reported similar rates (27%) of maternal undernutrition. This may indicate the lack or failure of program impacts to reduce undernutrition in women or other underlying factors that might have not been sufficiently targeted by existing health programs. Current levels are similar to levels reported by a study in the 1990s (Umeta, West, Verhoef, Haidar, & Hautvast, 2003). The EDHS 2011 also reported high rates (11%) of low birth weight (LBW) babies, which provides further evidence for the existence of high rates of undernutrition among Ethiopian women (CSA & ICF International, 2012). The incidence of LBW babies had been previously associated with poor maternal nutrition before and during pregnancy, particularly in poor countries (Kramer, 1987a; Ota et al., 2011; Ramakrishnan, 2004; WHO, 1995).

The effect of maternal undernutrition on the birth weight of babies in Ethiopia was not adequately represented as most mothers (95%) had their babies at home, instead of health facilities, and there was no information on birth weight of most babies born in the five years prior to the survey (Central Statistical Agency [Ethiopia] and ICF International, 2012). Therefore, the 11% LBW figure reported above likely underestimated the actual magnitude of the ill effect of maternal undernutrition on birth weights of babies in Ethiopia.

To tackle the lack of data on actual birth weight of babies, the mothers' subjective assessment of infant size at birth has been used in EDHS. Accordingly, in 2011 alone, mothers rated 30% of infants, born in the last five years preceding the survey, as 'smaller than average' (9%) or 'very small' (21%) at the time of birth (Central Statistical Agency [Ethiopia] and ICF International, 2012). This was comparable with what had been reported in the DHS 2005 (i.e., 28%) (Central Statistical Agency [Ethiopia] and ORC Marco, 2006). These figures were much higher than the target set by the 1990 World Summit for Children to reduce prevalence of LBW to <10% (UNICEF, 2012). Early studies have shown that LBW babies were more likely to remain 'shorter and lighter' in childhood (Binkin, Yip, Fleshood, & Trowbridge, 1988). In addition, LBW is a threat for child survival—it was shown as a major risk factor for neonatal and infant mortality and morbidity (McCormick, 1985).

Rural Ethiopia, where 80% of the population reside (Central Intelligence Agency, 2015), experiences chronic food insecurity and higher rates (29%) of maternal undernutrition compared with the rate in urban areas (20%) (CSA & ICF International, 2012). Several previous studies (Kramer, 1987a; Martorell & Zongrone, 2012; Masibo & Makoka, 2012; Meshram et al., 2012;

Meshram et al., 2014) emphasized the importance of improved maternal nutrition starting from pre-conception and continuing through pregnancy and lactation, which should also include improvements in the socioeconomic environment. This means maternal nutrition is key to combating LBW, stunting and associated neonatal-child mortality and morbidity during the first five years of life. Kramer (1987a), in a meta-analysis of 895 studies, identified maternal stature, pre-pregnancy weight and energy intake as nutrition-related factors which played key roles in aetiology of IUGR and the resulting LBW. This also adds emphasis to the significance of improved women's nutrition early in pregnancy for improved nutrition status of infants and young children later.

The vulnerability of Ethiopian women to poor nutrition has a gender dimension as well. Given women's triple responsibilities in *reproductive* (rearing children and household activities), *productive* (farming and income generating activities) and *social* roles, they tend to have less time to address their own needs (Mosse, 1993). Because of the perceived gender difference in many communities, women, despite their increased physiological needs, seldom get priority in intra-household food distribution, which in turn increases their vulnerability to malnutrition (FAO, 2010, 2012; Oniang'o & Mukudi, 2002).

In recent years, the government of Ethiopia has recognized the need to mainstream nutrition in a coordinated manner and address nutritional concerns of the population to ensure sustained human and economic development. To this end, the government, for the first time, designed the National Nutrition Strategy (NNS) and launched a National Nutrition Program (NNP) in 2008 (Ethiopia Federal MoH, 2008b). The first phase of NNP, spanning 2008-2013, was later revised and re-launched in June 2013 to cover the period 2013-2015. The intention for the revision was to align the end of Phase-I with the country's Growth and Transformation Plan (GTP) and with the end of the MDGs (FDRE, 2013). The NNS outlined pregnant and lactating women, as well as infants and children under five years of age, to be among priority groups for nutrition interventions, mainly delivered through the already in-place Health Extension Program (HEP). Implementation of the NNS helped coordinate fragmented efforts by various national and international agencies, and encouraging improvements were reported one year into the launch of the program (Save the Children UK, 2009).

However, results from the 2011 EDHS and EHNRI nutrition baseline survey (EHNRI, 2010) indicated that dietary practices were still suboptimal and as such may limit the successful outcomes of the NNP. For example, the 2009/10 NNP baseline report by EHNRI (2010), a national body responsible for conducting operational research, indicated that ~83.5% of rural women during their last pregnancy consumed meals that were the *'same-as'* or '*less than'* what they would consume when they were not pregnant. The right approach to take was to increase their overall dietary consumption to meet the increased demands pregnancy.

The 2011 EDHS also reported that only fewer than half of all infants (48.4%) started complementary foods at 6-8 months. The World Health Organization (WHO) strongly recommends that infants be introduced to safe and adequate complementary foods at the age of six-months. Preventing and reducing malnutrition in children <5y requires practicing appropriate infant and young child feeding, including exclusive breastfeeding for the first 6 months and complementary feeding from 6-months onward (WHO, 2008). Complementary feeding is described as the process of introducing other foods and liquids, in addition to breastmilk, into the child's diet when breastmilk alone is no longer sufficient to meet nutritional requirements of a growing child. In Ethiopia, only an estimated 52% of infants below 6-months of age were exclusively breastfed, based on the 2011 EDHS. The remaining infants were introduced to cereal-based complementary foods, plain water and milks before the recommended 6-months of age. Introduction of complementary foods too early or too late was associated in an increased chance of being stunted, according to studies in southern Ethiopia (Gibson et al., 2009; Tessema, Belachew, & Ersino, 2013).

Thus, one can argue that dietary practices of mothers and those of young children in Ethiopia have a long way to go.

Gaps in poor nutritional practices of mothers and children can be mitigated by appropriate and sustainable nutrition interventions. Linking agricultural practices to nutrition (i.e., leveraging agricultural products and shaping the practice toward improving the nutritional status of the population) presents the opportunity for nutrition interventions seeking to address gaps in maternal and child nutrition. The Ethiopian diet is mainly cereal-based (including *teff*—a cereal grain native to northeastern Africa—maize, sorghum, wheat, barley) and '*Enset*' (*Ensete ventricosum*, a banana like root-crop common in southern parts of Ethiopia). Cereals comprised about 85% of grain production (CSA, 2009). Pulses (e.g., dry beans, peas, chickpea, lentils) are the second most important crops in Ethiopia's smallholder agriculture, next to cereals. They serve as alternative sources of plant based-protein and other nutrients. In addition, they are good source of income and support household food security. The reason is that pulses are higher value crops than cereals, providing economic advantage to small farm holding households (Ethiopian Export Promotion Agency, 2004). Pulses have been used for many years in crop-rotation practices. Some of them have also played an important role in the export sector, generating foreign currency for the country. However, pulse production in Ethiopia is below potential. From the total grain crop production in 2008/9, pulses made up 11.48% (CSA, 2009). There is also a scarcity of research that characterize utilization of pulses and the barriers to consumption at household levels. Two separate studies in recent years have explored the role of pulses in the nutrition of young children (Mesfin, Henry, Girma, & Whiting, 2016) and adolescent girls (Roba et al., 2015) in selected rural communities from southern Ethiopia; findings have indicated limited use of pulses, and the studies have recommended nutrition education to narrow the gaps in utilization.

Furthermore, research that attempted to link agricultural practices to nutrition of mothers and children in Ethiopia are scarce. Particularly, studies that documented pulse agriculture-nutrition links, (i.e., documenting how household production of pulses affect the nutritional health of household members and/or the community) are limited. While a number of agricultural interventions failed to significantly impact nutritional health in children, largely because of their design (Masset, Haddad, Cornelius, & Isaza-Castro, 2012), a study (Bezner Kerr, Berti, & Shumba, 2011) in Northern Malawi is an example where participatory nutrition education, including individual home visits and group meetings, linked to legume/pulse agriculture brought positive changes on the growth of children.

Therefore, the aims of this project were as follows: to characterize the nutritional situation and compare the nutritional status of mothers and children in pulse versus mainly cereal-growing (i.e., no or limited pulse production) rural communities in Ethiopia; and to develop and implement a community-based nutrition education intervention, emphasising pulse consumption as part of healthy meals, in the pulse-growing communities in a quasi-experimental intervention design. The study was conducted in two rural communities from *Halaba*, a pulse-growing district in the SNNP Region, and one cereal-growing rural community near the town of *Zeway* in the Oromiya Region. Selection of these communities was purposive in accordance with the objectives of the current study, and the study communities were part of a bigger Ethiopia-

Canada research project that aimed at improving food security and human nutrition by improving agricultural productivity.

Although much of the current study occurred in the pulse-growing district of rural Halaba, there was a need for a similar rural community that was mainly cereal-based. During the selection of the specific communities, it was assumed that most rural communities in Ethiopia were similar in many aspects, particularly in availability of infrastructure (such as access to water, markets, roads, schools, health and agricultural extension services). The value of comparing nutrition of populations in pulse versus cereal-growing communities was to help strengthen the evidence that pulse agriculture can indeed have positive impact on nutrition of communities. This argument suffers some limitations, partly, because of the fact that the comparison communities were not purely pulse or cereal-growing, and/or the existence of other factors that might have not been controlled in this design. However, the inclusion of a cereal-based community selected by the local agriculture office provided a general comparison basis to examine the relationship between pulse agriculture practice and overall nutrition of mothers and children in such communities.

1.3. Research objectives and hypothesis

1.3.1. Objectives

1. Characterize the gender, socioeconomic and demographic factors, as well as nutritional status of mothers and their young children (<5y) in the selected communities, and compare outcomes with recent national and regional reports ***(Studies 1 - 3);***

   Specific objectives

   a. Assess and compare socioeconomic-demographic and nutrition/health related practises, as well as rates of maternal and child undernutrition with national and regional reports;
   b. Assess feeding practices in children <2y of age;
   c. Assess household food insecurity status in the study communities;

2. Compare maternal and child nutritional status in pulse crop growing and mainly cereal-based communities ***(Study 4);***

Specific objectives

a. Compare dietary practices and nutritional status of mother and children in pulse versus cereal growing communities;
b. Assess factors associated with maternal and child nutritional status in the context of production and utilization of pulse crops in the selected communities;

3. Design, implement and assess the effect of a community-based nutrition education intervention that emphasizes consumption of pulses as part of healthy meals, on the knowledge, attitude, practice (KAP) and nutritional status of mothers and children ***(Study 5);***

Specific objectives

a. Design and implement a community-based nutrition education intervention that centres around promotion of a pulse-based diet as part of healthy meals, in one of two pulse growing communities;
b. Assess the effect of the nutrition education on the KAP around pulse nutrition and nutritional status of mothers and children;

1.3.2. Hypothesis

1. Levels of maternal and child undernutrition in rural communities of *Halaba* and *Zeway* areas are comparable to target levels set in the Ethiopian national nutrition program ending by 2015 (i.e., 30% prevalence of stunting in children and 19% undernutrition in women of reproductive age).
2. Mothers and children in pulse growing communities have better nutritional status when compared with those in mainly cereal-based communities of rural Ethiopia.
3. Community-based nutrition education promoting pulses as part of healthy meals will improve the knowledge, attitudes and practices of communities toward pulse agriculture and consumption, and hence, the nutritional health status in mothers and their children.

1.4. Definition of terms

Body mass index: The ratio of weight in kilograms to height in meter squares;

Maternal undernutrition:	Chronic energy deficiency defined by a low BMI of less than 18.5kgm^{-2};
Stunting (Shortness):	Failure to reach linear growth potential, usually defined by a low height-for-age z-score (i.e., <- 2 SD from the median height of the reference population);
Wasting (thinness):	Failure to gain adequate weight (or loss of weight) relative to height, usually defined by having low weight-for-height z-score (i.e., <-2 SD from the median weight of the reference population);
Underweight (lightness):	Failure to gain adequate body mass relative to chronological age, usually defined as having low weight-for-age z-score (i.e., <-2 SD from the median weight of the reference population); underweight could be due to having low height-for-age (stunting) or low-weight-for-age (wasting) or both.
Low Birth Weight:	A birth weight of < 2500g at term delivery;
Pulses:	Refers to "dry seeds of leguminous plants which are distinguished from leguminous oil seeds by their low fat content"[1] and may include dry beans (haricot bean, faba bean), lentils, peas, chick peas and others;
Pulse-growing communities:	Communities where most (i.e., >50%) farming households grow pulses as part of their normal crop production and that frequently grow one or more of the common pulse crops in Ethiopia;
'Non-pulse growing' or mainly cereal-based communities:	Communities where most (i.e., >50%) farming households do not grow any of the major pulse crops grown in Ethiopia or grow one or more of these only in small quantities as compared to those communities identified as pulse growing.

[1] (FAO and WHO, 2007)

Chapter 2 Literature review

2.1. Introduction

The purpose of this chapter is to provide a review of the available literature on child stunting, maternal undernutrition and dietary practices (as it relates to child stunting), as well as pulse agriculture in the context of improving maternal and child nutrition in Ethiopia. The review also highlights whether agricultural interventions (including pulse production) have affected nutritional health in populations or subgroups in Ethiopia or elsewhere.

The first half of the chapter provides an overview of general nutrition concerns in Ethiopia and, to some extent, in SNNPR based on recent Ethiopian Demographic and Health Surveys (EDHS) and other studies. This is followed by a description of the etiology of child stunting (linear growth faltering and most common indicator of chronic child undernutrition), why it matters, a description of the global burden of stunting and where Ethiopia fits in the overall picture, including Ethiopia's progress in the last two decades. A brief overview of the policy environment and socio-economic and demographic factors that may have affected progress in overcoming child undernutrition are discussed in the subsequent sections. Then, a review of maternal undernutrition and dietary practices of mothers and young children in relationship to stunting are included.

The second half of the literature review deals with nutrition related characteristics of pulses, pulse-agriculture and their roles in diet. The addition about pulse crops to literature review was because part of the objective of the study was to document evidence of how pulses might have contributed to the nutrition of mothers and children—a segment of the population considered most vulnerable to malnutrition. Hence, the subsequent sections present brief descriptions of the roles of pulses in human nutrition and an overview of the Ethiopian diet and pulses in the Ethiopian diet, including a review of commonly grown pulses in Ethiopia (i.e., *"what",* "*where"* and "*how much"*). The final sections comment on the literature regarding interventions that have attempted to link pulse-agriculture to maternal and child nutrition in Ethiopia or elsewhere, reflect on the need to integrate nutrition education with agricultural practices and highlight common theories used in nutrition education interventions. The closing section describes future prospects of pulses in terms of their contribution toward addressing micronutrient deficiency in Ethiopia followed by a brief summary of the literature.

2.2. Nutrition concerns in Ethiopia: overview

Located in the horn of Africa, Ethiopia is the second most populous country in Africa next to Nigeria. Despite the slight decrease in the per annum growth rate (from 3.1 in 1984 to 2.6 in 2007 and 2.89 in 2014), the total population was estimated at 96.6 million by July 2014 (Central Intelligence Agency, 2015; CSA & ICF International, 2012). The 2011 human development report of the United Nation Development Program (UNDP) ranked Ethiopia 174, which slightly improved to 173 in 2013, out of 187 countries based on the Human Development Index (HDI) (United Nations Development Programme, 2014). The HDI is a multidimensional human development indicator reflecting a country's educational status (estimated via average year of schooling at age 25), standard of living (estimated via per capita income) and, health status (estimated via life expectancy) (United Nations Development Program, 2011). The report indicated that Ethiopia's average HDI of 0.363 in 2011 was below the average for sub-Saharan African countries (i.e., 0.463). An HDI closer to 1 generally indicates better human development. A more recent report (United Nations Development Programme, 2014) showed a modest improvement in HDI (i.e., 0.458 compared to 0.394 in 2008) but still remained below the average for sub-Saharan Africa (i.e., 0.502), which itself was the lowest among all other regions of the world. Though the economy is growing steadily, Ethiopia is still among one of the poorest in the world, ranking 208 with a GDP per capita (in Purchasing Power Parity) of 1,800 USD (Central Intelligence Agency, 2015). Almost half of the country's GDP came from mostly rain-fed and subsistence agriculture, which also provided employment to 85% of the work force in the country (Central Intelligence Agency, 2015; FAO, 2008).

Malnutrition, along with infectious diseases, lack of improved water sources and sanitation, were reported as major public health concerns in recent years in Ethiopia with its rapidly growing population (FAO, 2008). According to the UNICEF ranking, Ethiopia stood second in Africa (7th globally) for having the highest number of stunted children (UNICEF, 2009). The country still battles high rates of both macro- and micronutrient deficiencies. Most common forms of malnutrition in Ethiopia include acute and chronic undernutrition, vitamin A deficiency, iron deficiency anemia , and iodine deficiency disorder (FAO, 2008). In the 2011 EDHS, the prevalence of stunting, underweight and wasting among children under five years of age was reported as high as 44.4%, 28.7% and 9.7%, respectively (CSA & ICF International, 2012).

Prevalence of undernutrition among reproductive age women also remains high in Ethiopia. Both the 2005 and 2011 EDHS reported a 27% (more than one in four) rate of undernutrition (i.e., a BMI < 18.5) in women. The 2011 EDHS also indicated that the proportion of babies born with low birth weight (i.e., birth weight < 2500g) in Ethiopia was one of the highest (11%) with closely to 30% of babies subjectively estimated as 'very small' or 'smaller' than average.

Only 15% of households used iodized salt in the 2011 EDHS survey, and the proportion of children below the age of five who lived in such households was only 16%; nearly half (44%) of 6-59 month old children were anemic and only 6% of children in this age group received iron supplements in the 7 days prior to the survey; only one in four 6-23 month old children consumed vitamin A rich foods in the day before the interview, and just over half (53%) of children aged 6-59 months received vitamin A supplements (CSA & ICF International, 2012). Similarly, the 2011 EDHS also reported low coverage of vitamin A supplementation for women with only 16% of mothers receiving postpartum vitamin A supplements in the five years preceding the survey. Evidence of the existence of deficiencies in other micronutrients, such as zinc, among women and children has been reported in various parts of Ethiopia by smaller studies (Abebe et al., 2008; Gebremedhin, Enquselassie, & Umeta, 2011; Gebreselassie & Gashe, 2011; Gibson et al., 2008; Umeta, West, Haidar, Deurenberg, & Hautvast, 2000). Undernutrition has also been reported to be responsible for 28% of all child deaths in Ethiopia in the period 2005-2009 alone (African Union Commission et al., 2014).

With an effort to alleviate the widespread malnutrition in the country, the government of Ethiopia recently devised a National Nutrition Strategy (NNS) (Ethiopia Federal MoH, 2008a) and launched a National Nutrition Program (NNP) in 2008 (Ethiopia Federal MoH, 2008b).

The Southern Nations, Nationalities and Peoples Region (SNNPR), located in the south, is one of the nine administrative regions in Ethiopia. The nutrition concerns in this region were similar to what was reported at the national level. For instance, the 2011 EDHS rates of stunting, wasting and underweight, were high at 44 %, 8% and 28% respectively, in SNNPR. Likewise, the median duration of exclusive breastfeeding in SNNPR was only 2.2 months (2.3 nationally) for children born in the three years preceding the survey. This means every other child (50%) is exclusively breastfed for only 2.2 or fewer months, a duration much less than the six months recommended for exclusive breastfeeding by WHO (WHO, 2016; WHO & UNICEF, 2003). The proportion of breastfed children in SNNPR (6-23 months) who were fed meals from ≥4 food groups[2] was only 2.5%, whereas the proportion of those who were fed with minimum-meal frequency[3] was 48.9%. This meant only 2.3% infants and young children in the region were fed on acceptable diet (i.e., one that met both the minimum meal frequency and dietary diversity), which was not different from respective figure (4%) reported nationally (CSA & ICF International, 2012). Prevalence of anemia among children in the region was high (37%), a level WHO categorizes as being a moderate public health problem (WHO, UNU, & UNICEF, 2001). According to the EDHS (2011), children in SNNPR were among the least likely (6% only) to consume iron rich foods. The survey also indicated that supplementation of vitamin A and iron was low at 43.9% and 3.9%, respectively.

Trends similar to national figures were observed in SNNPR for maternal undernutrition, prevalence of iodine deficiency disorders and proportion of households using iodized salt (Abuye & Berhane, 2007; CSA & ICF International, 2012; Ersino, Tadele, Bogale, Abuye, & Stoecker, 2013).

2.3. Stunting: etiology, global burden and Ethiopia

2.3.1. What is stunting?

Stunting, an indicator of chronic undernutrition in children, starts early in life and is expressed as deficit in linear growth two standard deviations below the median height of the reference population. The worldwide timing for growth faltering has been shown to start in the uterus, hitting its peak in the first 24 months after birth and staying relatively constant beyond 24 months of age (Victora, de Onis, Hallal, Blossner, & Shrimpton, 2010). This indicates that the period from conception through the first 2 years of age is critical for prevention of stunting. Although stunting is usually expressed as linear growth faltering, its consequences are broad spectrum, severe and long lasting.

The etiology and timing of stunting could vary among populations based on cultural, biological and environmental backgrounds. Studies in the 1990s described nutrition and maternal

[2] Food groups: a. infant formula, milk other than breast milk, cheese or yogurt; b. foods made from grains, roots, and tubers, including porridge and fortified baby food from grains; c. vitamin A-rich fruits and vegetables; d. other fruits and vegetables; e. eggs; f. meat, poultry, fish, shellfish, and organ meats; g. legumes and nuts.

[3] For breastfed children, minimum meal frequency is receiving solid or semi-solid food at least twice a day for infants 6-8 months and at least three times a day for children 9-23 months.

related factors as predictors of growth faltering in infants and young children. Neumann and Harrison, based on a nutrition study in Kenya, Egypt and Mexico, argued that causes of early onset of growth faltering can be traced back to the maternal pre-pregnancy and pregnancy nutrition situation, such as maternal weight at the start of pregnancy and weight gain during pregnancy (Neumann & Harrison, 1994). Neumann and Harrison also noted that energy intakes of mothers in Kenya declined progressively during pregnancy and the mothers gained only half as much weight as mothers from North America or Europe. The study observed poorer quality diets and low intakes of zinc and iron with low bioavailability because of considerable anti-nutritional factors (such as phytate, fiber, tannins) in the diet. Earlier studies also indicated that stunting begins to manifest as early as two or three months of age although much was not known on the mechanism and process of becoming stunted (Waterlow, 1988; Waterlow, 1993). Observational studies in India and Bangladesh also found various environmental, socio-economic and nutritional predictors of stunting, including being in the middle or low-wealth category, thinness, fathers' education, household income, age of child, birth-order, toilet facilities and others (Meshram et al., 2012; Mostafa, 2011). Overall, causes of stunting or undernutrition could be diverse and could vary across cultural, environmental and socio-economic backgrounds; hence, the strategies to mitigate the problem should also be diverse.

2.3.2. Stunting and zinc deficiency in children

Zinc is an essential micronutrient needed by the human body and ubiquitously present in all organs, tissues, fluid and secretions of our body; the human body contains about 1.5-2.5 grams of zinc, which is homeostatically maintained by absorption of about 5mg of zinc per day from the small intestine (IZiNCG et al., 2004). The functions of zinc in our body can be summarized as *catalytic* (as zinc is found in all six groups of enzymes), *structural* (zinc is component of metalloenzymes [enzymes containing metal ions] and also cell membranes helping cells fight free radicals) and *regulatory* (in gene expression, apoptotic cell death and synaptic signaling) (Brown, Peerson, Rivera, & Allen, 2002; Gibson, 2006; IZiNCG et al., 2004).

Thus referencing the multiple roles of zinc in our body, Gibson (2006) argues that zinc deficiency affects various body functions including physical growth, immune functions, and neuro-behavioural and reproductive functions. The IZiNCG technical document described in details the effect of zinc on growth and development across the life stages of various population groups, including pregnant and non-pregnant women, infants and young children (IZiNCG et al., 2004). From multiple possible causes, such as inadequate intake, malabsorption, increased loss, impaired utilization and increased requirement, poor dietary intake was suggested as the major and most likely cause of zinc deficiency.

The effect of zinc deficiency on the linear growth of children was reported in the early 1960s when it was first described as the likely cause of dwarfism (abnormally short stature) and hypogonadism (absence or reduced testosterone secretion of the gonads) in Iranian boys who consumed diets high in phytate and inadequate in animal source foods (Prasad, Schulert, Miale, Farid, & Sandstead, 1963). After the first report of zinc deficiency as a possible cause of linear growth faltering in humans, several randomized control trial (RCT) studies have been conducted to quantify and establish the effect of zinc in growth and development. Following a meta-analysis of 33 RCT studies, Brown and colleagues reported a significant increment in height, height-for-age z-scores and weight of zinc-supplemented children (Brown et al., 2002). Brown et al. also indicated that effect of zinc supplementation was greater in children whose initial height-for-age z-scores (HAZ) and weight-for-age z-scores (WAZ) were low. Another RCT study in Indonesia has also reported that zinc and iron, supplemented together, significantly increased linear growth in stunted infants (Fahmida, Rumawas, Utomo, Patmonodewo, & Schultink, 2007). An RCT study in rural Ethiopia in the mid-1990s showed that stunted children who were zinc supplemented gained a significant increment in linear growth and also manifested significantly lower rates of morbidities from infectious diseases (Umeta et al., 2000). A related observational study in Ethiopia also indicated that higher rates of growth faltering (stunting) were observed in infants whose mothers' breast-milk zinc content was lower, and in infants who were fed with low quantity and quality complementary foods (Umeta et al., 2003).

Considering the challenges in the availability of data to directly estimate prevalence of zinc deficiency in many developing countries, IZiNCG suggested other ecological and health indicators to assert risk of zinc deficiency at a population level. These included prevalence of stunting, rate of anemia and type of food available for consumption (with emphasis on phytate contents) in a population. Accordingly, a ≥20% prevalence of stunting along with heavy dependence on foods containing high levels of phytate in populations, was suggested to signify high risk of zinc deficiency in that population (Gibson, 2006; IZiNCG et al., 2004).

Based on this evidence, one can deduce that zinc deficiency plays an important role in the prevalence of stunting in young children. Hence, interventions targeting reduction in stunting prevalence should also aim to address zinc deficiency in their programs.

2.3.3. Why stunting is important

Early childhood stunting, along with absolute poverty, has been reported as a factor denying the full development potential of over 200 million children younger than 5 years in South Asia and Sub-Saharan African countries (Grantham-McGregor et al., 2007). The number of children <5 years of age affected by stunting dropped to 165 million in 2011 (Black et al., 2013). Based on several cross-sectional and longitudinal studies in affected countries, Grantham-McGregor and colleagues reported how stunting predicted poor cognition and/ or poor school progress later in life in stunted children compared with non-stunted children. The loss of intellectual capacity, or cognitive deficit, later in life was also reported in other studies (Black, 2005).

Further study also reported that poor early childhood growth (stunting) in the first two years of life or poor foetal growth in the period of pregnancy, during which vital development in all aspects occurs, results in irreversible damages, including short adult stature, lower attained schooling, reduced adult income and lower birth weight *(of term babies)* in offspring (Victora et al., 2010). The same article added that children undernourished in the first two years of life and who quickly add weight in late childhood and adolescence have higher chances of suffering from nutrition related chronic diseases. A more elaborate effect of childhood stunting has been discussed in a technical brief on ‘Why stunting matters’ by Alive and Thrive (Alive and Thrive, 2010).

2.3.4. Stunting in Ethiopia: The last two decades

2.3.4.1. Trends and progress in reduction

In the year 2009, Ethiopia was placed 7th worldwide and 2nd in Africa as a county with the highest burden of stunted children under the age of five years (estimated at 6.7 million in total) (UNICEF, 2009). Through the last two decades, reduction in the prevalence of stunting has shown a gradual improvement, and the country appeared better positioned to meet its Health Sector Development Program-IV (HSDP)[4] and MDG-1 by 2015.

The MDG-1 and HSDP III/IV had the goal of reducing underweight and stunting, respectively, by 50% from what had been reported in the 1996 Welfare Monitoring Survey of Ethiopia (WMS) (Ethiopia Federal MoH, 2008a; Federal Ministry of Health of Ethiopia, 2005).

Although high levels of chronic malnutrition have characterized Ethiopia in sub-Saharan Africa and globally, efforts to combat malnutrition through various governmental and non-governmental agencies in the last ten years have begun to gradually reduce stunting and underweight in children. According to the most recent EDHS report, a 44.4% prevalence of stunting among children <5 years of age was a result of 1.34% decrease per year during the five years since the 2005 EDHS, which had reported a 51.5% prevalence of stunting (CSA & ICF International, 2012). The NNP baseline survey by the Ethiopian Public Health Institute, formerly Ethiopian Health and Nutrition Research Institute, (EHNRI, 2010) also reported a 38% prevalence of stunting (based on NCHS/CDC 1978 growth reference), which was close to 44.1% when converted based on the new WHO growth standard using the WHO algorithm (Yang & de Onis, 2008). When the progress in the reduction of stunting was compared to earlier EDHS reports (57.8% in 2000 and 51.5% in 2005), the five years prior to 2011 EDHS showed slightly better progress with a 1.42% reduction in stunting per annum as opposed to 1.26% in the previous five years (see Table 2.1).

The five years following EDHS 2005 were also the years Ethiopia showed a national drive toward combating chronic malnutrition by introducing a National Nutrition Strategy (NNS) (Ethiopia Federal MoH, 2008a) and a National Nutrition Program (NNP) (Ethiopia Federal MoH, 2008b) with special emphasis to target children under the age of five years, as well as pregnant and lactating mothers. Despite progress in reducing the rate of underweight (an indicator of 'lightness' or inadequate weight to chronological age) in children, progress in reducing the prevalence of wasting (an indicator for "thinness"—a marker of acute malnutrition) was slow.

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[4]The HSDP is a 20-year national program developed by the Ethiopian Government and is the health part of a bigger program called a Plan for Accelerated and Sustained Development to End Poverty (PASDEP). The HSDP is aimed to be in line with the MDGs and seeks to improve health service delivery, capacity building and development of preventive health care and equal access to health services (http://webapps01.un.org/nvp/indpolicy.action?id=131#).

Table 2.1 Comparing trends in selected anthropometric indices of nutritional status among under five years of age Ethiopian children based on the old NCHS/CDC reference and the WHO Growth Standard and according to EDHS and NNP baseline Surveys

Indicators	Reference used for indicator	WMS 1996	EDHS 2000	EDHS 2005	EDHS 2011	EHNRI 2010	MDG 1 Target
Stunting	NCHS/CDC	65.7	51.5	46.5	38.3	38.0	-
(HAZ<-2SD)	WHO 2006	69.4	57.8	51.5	44.4	44.1	34.7
Wasting	NCHS/CDC	7.3	11.0	10.5	8.1	11.7	-
(WHZ<-2SD)	WHO 2006	8.8	12.9	12.4	9.7	13.6	-
Underweight	NCHS/CD	45.4	47.0	38.4	32.3	33.9	-
(WAZ<-2SD)	WHO 2006	41.1	42.1	34.9	28.7	30.2	20.6

WMS= Welfare Monitoring Survey of Ethiopia; EDHS= Ethiopian Demographic and Health Survey; EHNRI= Ethiopian Health and Nutrition Research Institute; MDG=Millennium Development Goal; WHO = World Health Organization; NCHS/CDC=National Centre for Health Statistics/Center for Disease Control

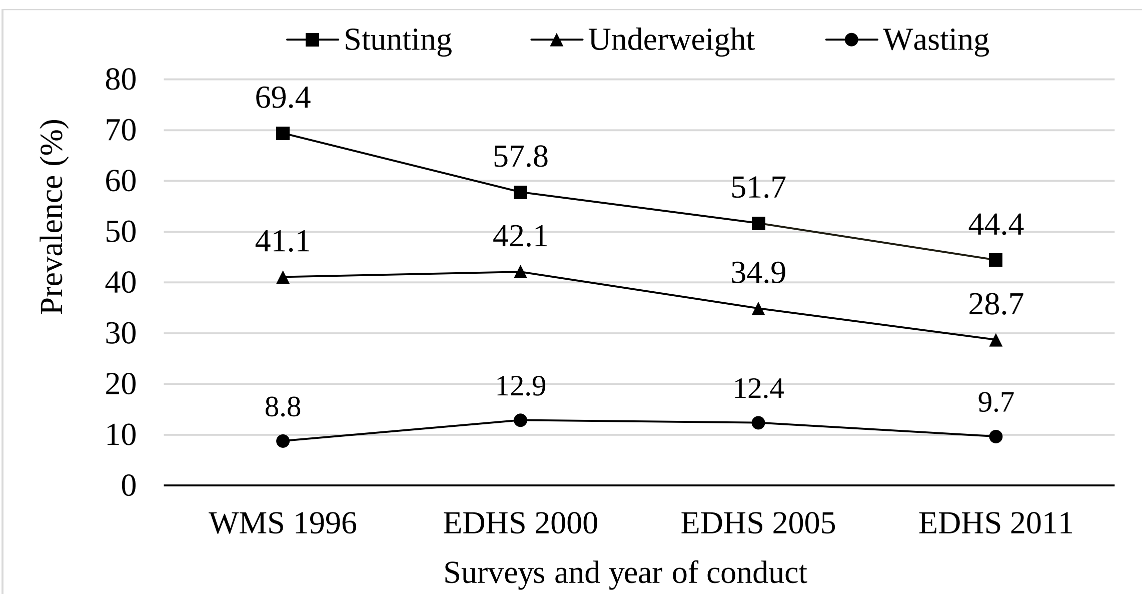

Figure 2.1 Trends in the prevalence (%) of child stunting, wasting and underweight in Ethiopia based on the WHO 2006 Growth Standard (Date source: EDHS Surveys and WMS 1996)

2.3.4.2. Prevalence and progress in reduction of stunting in SNNPR

Prevalence levels of child stunting and other anthropometric indices in SNNPR for the last two decades have been summarized in Table 2.2. The data shown in the table were taken from the 1996 Welfare Monitoring Survey and the last three Demographic and Health Surveys of Ethiopia. To make comparison possible, prevalence levels have been presented based on both the WHO 2006 growth standard and the older 1977 NCHS/CDC references. Accordingly, all previous prevalence levels, except for the 2011 EDHS, have been converted (using the WHO recommended algorithm) to what they would be when compared with the new WHO growth standard (Yang & de Onis, 2008). Results for similar indices from the 2009/10 EHNRI's baseline survey report for the NNP were also included for comparison purposes.

Table 2.2 Child stunting, wasting and underweight in SNNPR: prevalence estimates for the last 20 years based on the 1977 NCHS/CDC reference versus the WHO 2006 growth standard

Indicators	Reference used for indicator	WMS 1996	EDHS 2000	EDHS 2005	EHNRI 2009	EDHS 2011
Stunting	NCHS/CDC	69.3	55.4	51.6	41.7	38.0
	WHO 2006	72.5	60.3	56.8	47.7	44.1
Wasting	NCHS/CDC	5.9	11.8	6.5	9.3	6.2
	WHO 2006	7.3	13.7	8.0	11.0	7.6
Underweight	NCHS/CD	49.6	53.7	34.7	34.6	31.8
	WHO 2006	45.2	49.2	31.0	30.9	28.3

SNNPR= Southern Nations, Nationalities and People's Region; WMS=Welfare Monitoring Survey of Ethiopia; EDHS=Ethiopian Demographic and Health Survey; EHNRI=Ethiopian Health and Nutrition Research Institute; MDG=Millennium Development Goal;

To show the trends in the prevalence of stunting, wasting and underweight (Figure 2.2), only rates calculated based on the new WHO growth standard were used. Prevalence of stunting has been decreasing by 0.7 and 2.54 percent per year for the period 2000-2005 and 2005-2011, respectively (CSA & ICF International, 2012; CSA and ORC Marco, 2006). Reduction of stunting in SNNPR appeared more quickly in the five years prior to EDHS 2011 compared with earlier rates. However, the rate of reduction in underweight (a combination of chronic and acute malnutrition) dropped from 3.64% per year in 2000-2005 to 0.54% per year in 2005-2011. This could be because of the poor progress in the reduction of wasting among children under five years of age in the region, which might have slowed progress toward set goals (i.e., halving the level in 1996 WMS by the end of 2015).

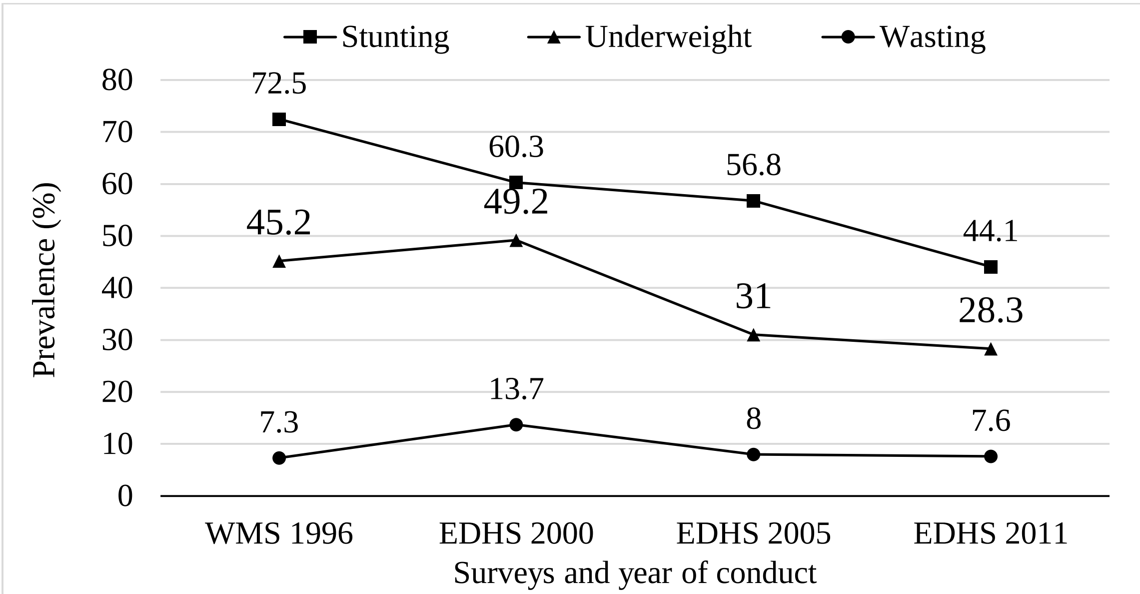

Figure 2.2 Trends in child stunting, wasting and underweight prevalence (%) in Southern Nations, Nationalities, and people's Region based on DHS data for the last two decades

2.4. Policy, socioeconomic-demographic, food security and gender related factors that might have influenced progress in the reduction of child undernutrition

The past few years have seen a general pro-nutrition environment at the national level in Ethiopia. They were marked by the commencement of a national Health Extension Program (HEP); development and implementation of the National Nutrition Strategy (NNS) and National Nutrition Program (NNP); graduate and undergraduate level nutrition training programs at various higher institutions; the Health Sector Development Program (HSDP), which Ethiopia launched as a 20-year program; as well as improvement in food security programs and other initiatives (such as Enhanced Outreach Strategy to Health Extension Program, Scaling Up Nutrition). However, no formal evaluations have been reported to measure the impact of any of the ‘interventions’ that might have contributed to the reduction of malnutrition in the country (Ersino, 2011). Partly, this may have been due to the relative newness of most nutrition programs in the country—being implemented only in the last few years.

Although formal evaluation reports, which may provide grounds to determine what has or has not been working, are currently lacking, improvements in the policy environment, certain demographic and socioeconomic characteristics (including addressing gender equality) and changes in the health seeking behaviour of the population might have contributed to the observed gradual progress. These factors could directly or indirectly affect or be affected by the improvement in nutritional status of women and children. Some such factors, as observed mostly from EDHS surveys, have been briefly described below.

2.4.1. Policy related factors

2.4.1.1. Nutrition policy

In 2008, Phase I of the first National Nutrition Program (NNP) was in place with an overall objective of improving the nutritional and micronutrient status of the population, especially of mothers and children (Ethiopia Federal MoH, 2008b). The NNP had two major components: strengthening nutrition service delivery and strengthening institutions for nutrition policy and program implementation. The program also had four specific key performance indicators in terms of reducing (1) prevalence of underweight from 38% to 30% by 2013, (2) prevalence of stunting from 46% to 40% by 2013, (3) prevalence of wasting from 11% to 5% by 2013 and (4) prevalence of LBW from 13.5% to 10% by 2013 or reducing the percentage of births considered smaller than normal from 28% to 24%. The Health Extension Program, Community Based Nutrition, Health Facility Nutrition Service and Micronutrient Interventions were set as service delivery platforms for the implementation of the program. A few years into the implementation, the government realized the need for revision of the first phase of the NNP and came up with the revised NNP in June 2013, which was implemented towards the MDGs in the remaining two years (FDRE, 2013).

The main reasons for the revision were to (a) strategically address the nutrition problems of the country following the lifecycle approach and considering the multisectoral and multidimensional nature of nutrition, (b) integrate new nutrition initiatives (such as accelerated reduction in stunting) and strengthen the ones that were not adequately captured or emphasized, and (c) extend the first phase of the NNP 2008 by two more years to align it with the end of the MDGs and with the end of the country's five year Growth and Transformation Plan (GTP), which also included 'reduction of stunting' as one of its target goals. The revised NNP also aimed to utilize the same service delivery platforms as the old NNP and set three main performance indicators which, in many ways, resembled the ones in the NNP 2008. The performance indicators were (1) “reduce the prevalence of stunting from 44.4% to 30% by 2015,” (2) “reduce the prevalence of wasting from 9.7% to 3% by 2015” and (3) “reduce the prevalence of chronic undernutrition in women of reproductive age from 27% to 19%” (FDRE, 2013).

Different papers and reports were presented at the launching event of the revised NNP at the UN Economic Commission for Africa, in Addis Ababa, Ethiopia. Some of the papers were aimed at ensuring continued political commitment from the government by presenting (in monetary terms) how much undernutrition in children has been costing the country. One such report was the Ethiopian version of “The Cost of Hunger in Africa” study, a project led by the African Union Commission and supported by other UN agencies (African Union Commission et al., 2014). The study estimated the social and economic impact of undernutrition in children less than five years of age on the economy of the country by calculating the additional cost of child mortality, morbidity, school repetition, school dropouts and reduced physical activity associated with undernutrition. Accordingly, it was estimated that Ethiopia had lost about $4.7 billion (16.5% of its GDP) due to child undernutrition in the year 2009 alone.

Three other African countries (Egypt, Uganda and Swaziland) were also involved in the study (which was said to be only the first phase of the ‘Cost of Hunger in Africa’ project (African Union Commission, NEPAD Planning and Coordinating Agency, UN Economic Commission for Africa, and UN World Food Programme, 2014). The equivalence losses of these countries as indicated on the report were $3.7 billion (1.9% GDP) for Egypt, $899 million (5.6% GDP) for Uganda and $92 million (3.1% GDP) for Swaziland. Compared to the losses suffered in the other African countries, child undernutrition had a greater cost on Ethiopia (16.5% of its GDP). This, of course, highlighted the need for continued efforts to fight child malnutrition in the country and, hence the need for revising the NNP. The revision and the re-launching also indicated the positive policy environment that has helped and will continue to help the reduction of child malnutrition in the country.

2.4.1.2. Food security situations and food sovereignty

Although food security does not always translate to nutritional health, the former tends to gain much attention and comes almost as a prerequisite to nutrition security. The United States Aid for International Development (USAID) (Coates, Swindale, & Bilinsky, 2007) defines food security as a condition in which "all people at all times have both physical and economic access to sufficient food to meet their dietary needs for a productive and healthy life."

In Ethiopia, some section of the population has always experienced a shortage of food supply and depended upon emergency food aid. Before the 1984 drought, Ethiopia was reportedly self-sufficient at least in cereal grains; but after the drought, which was very severe in magnitude, the livelihood of many people was so drastically affected that the country has never fully recovered to become self-sufficient in its own food supply (Jayne & Molla, 1995). From 1994-2003, there was an estimated average of 5 million people in need of emergency food assistance and the number of people ranged from 5-14 million from 1998 through 2003 (Devereux, Sabates-Wheeler, Tefera, & Taye, 2006). The report by Devereux, et al. (2006) also indicated that most of these people were not prone to famine per se, but were chronically food insecured (predictable food shortage) due to agricultural productivity and poverty issues.

In response to these and to break the cycle of seasonal food insecurity, the government of Ethiopia launched a special food security initiative called Productive Safety Net Program (PSNP) in 2004 & 2005 (Devereux et al., 2006). The PSNP was designed as an asset-protecting mechanism for the household in times of food shortage. The program provided food and/or cash just enough to meet the food demands of vulnerable households, while at the same time building community assets from the work program participants would offer in exchange for the food or cash they received. The program was intended to last for five years, by the end of which participants were expected to `graduate`-meaning they would have developed the economic strength to resist chronic food insecurity. Devereux et al. (2006) also pointed out that initially the PSNP targeted 5 million chronically food insecured people in 2005, which grew to 8 million in 2006. A food security update by international agencies in August 2009 indicated there still remained 6.2 million food insecured people (Famine Early Warning Systems Network, 2009).

According to FAO and WFP reports for the same year, the 6.2-6.4 million people were newly identified and in addition to the 7.5 million who were already in the PSNP with no sign of improvement in the immediate future (FAO & WFP, 2009). The report by FAO/WFP also indicated that there was, however, improvement in food production at the national level. The 2010 update indicated that because of the poor rain pattern in 2009, there were an estimated 5.23-6.5 million people in need of food assistance between February and June 2010 (FAO & WFP, 2010). The most recent report on the food security situation of the country by the FAO and the WFP indicated a relatively lower number (3.2 million) of beneficiaries identified for food assistance in the first half of 2012, which, according to the report, was a reduction from 4.5 million in 2011 (FAO & WFP, 2012).

Most of these reports indicated that the PSNP has significantly transformed the government's food security policy from a mere emergency food aid delivery system to a more productive, asset building and poverty alleviating tool. The most recent report (FAO & WFP, 2012) also attributed the current progress in the reduction of chronic malnutrition in children to the observed economic growth, infrastructure development and the PSNP programs.

However, it is important to note that food security does not always translate to nutrition security (World Bank, 2007) as adequate nutritional health is affected not only by the availability, but also by the access and utilization, of adequate and quality food. The current prevailing market system (a neoliberal approach that encourages market liberalization, with no or limited public investment by governments) has not always benefited developing nations in terms of reducing poverty. In fact, this approach has been criticized for worsening, instead of reducing, poverty in many developing nations (Oberdabernig, 2010; Shah, 2013). It was mainly encouraged, at times 'imposed,' by the global financial institutions—World Bank and IMF—on poor countries, under a package of special programs called *Structural Adjustment Programs (SAP)*. The SAP were meant to reduce poverty. Critics argue that this approach, for instance, encourages increased production in the agriculture sector, making more food available; however, since it also encourages competitiveness through trade liberalization in the global market, countries were forced to focus on a few select crops (leading to mono-cropping) in order to stay competitive in the global food market, thereby ending up with less diverse food and an unsustainable way of food production (Shah, 2013).

Critics of SAP also added that the type of production SAP encourages—where only selected food crops are grown through intensive application of synthetic fertilizer, pesticides and irrigation in mechanized farming—is not only environmentally unsustainable, but also favors only a few capable farmers who already have access to markets and the means to invest, and not the majority of poor smallholder farmers in the global south (Sub-Saharan Africa, southeast Asia, Latin America). The lack of diversity in crop production may lead to lack of dietary diversity for consumption, which in turn, contributes to micronutrient deficiency and hence, nutrition insecurity. Lack of dietary diversity has been linked to poorer nutritional status and micronutrient deficiency both in children and mothers in Ethiopia (Abebe et al., 2008; Gebremedhin et al., 2011; Gibson et al., 2009; Gibson et al., 2008; Tessema et al., 2013).

There is a growing momentum by a global movement of smallholder peasants, farmers, women and indigenous people towards ensuring not only food security but also *"Food Sovereignty."* Food Sovereignty is "the right of people to healthy and culturally appropriate food produced through ecologically sound and sustainable methods. …it is also the right to define and control our own food and agriculture system, including markets, production modes, food culture and environments" (Wittman & Desmarais, 2012). This international movement of farmers (also known as *La via Campesina*, the Farmers' Way) was born due to the inattention of food security to issues, such as how food should be produced and distributed, what is produced and who controls it; it advocates for a more sustainable, ecologically sound, healthy and democratic food system (Wittman & Desmarais, 2012).

Following criticism on the failed SAP, the World Bank reconsidered the structural adjustment programs—introducing an initiative called 'adjustment with a human face' where it allowed the developing nations to actually participate in designing the adjustment programs and coming up with their own poverty reduction programs. However, food sovereignty activists like Raj Patel still argued that the new 'adjustment with a human face' was not that different from its predecessor—saying the participation was nominal since the World Bank would have the final say on any programs poor countries propose (Patel, 2007).

Since Ethiopia is one of the developing countries from the global south working with World Bank and IMF, the effect of these adjustment programs would have an impact, at least in principle, on the economy of the country. However, in practice, the extent of the damage or its positive contribution in terms of reducing poverty and improving food/nutrition security needs to be studied in detail for a reliable comment on the matter.

2.4.1.3. Per capital income (Gross Domestic Product-GDP): Economy

It was earlier mentioned that Ethiopia was ranked 174 out of 187 countries based on the 2011 Human Development Index (HDI) report of the United Nations Development Program (UNDP) (United Nations Development Program, 2011). The HDI is a multidimensional human development indicator reflecting a country's educational situation (average year of schooling at age 25), standard of living (per capita income) and life expectancy (long and healthy life) (UNDP, 2011). Ethiopian's HDI rank in 2011 was similar with that of 2010. The country's rank in 2003 was 170 (The United Nations Development Programme, 2005). Generally, HDI rank of Ethiopia has remained low through the last two decades and the trend in the actual HDI (0.274, 0.313, 0.353, 0.358, 0.363 and 0.458 for the years 2000, 2005, 2009, 2010, 2011 and 2013, respectively) has been categorized as low (United Nations Development Programme, 2011; United Nations Development Programme, 2014). It was evident from the report that the trend in HDI in Ethiopia was also below that of the average for sub-Saharan African countries (i.e., 0.463 in 2011 and 0.502 in the 2014 HDI report). These figures in general imply that the country has much to work on in the areas of health (for which nutrition is a component in the calculation of the index), education and quality of life, all of which ultimately would improve the trend in HDI of Ethiopia.

On the other hand, Ethiopia's economy in recent years has been described as one of the fastest growing (non-oil) economies (with a ~9% - 13% growth rate), and the per capita income has improved to 390 USD though it still remains below the averages for low-income countries (530 USD) and that of sub-Saharan Africa (1,188 USD) (World Bank, 2012). The improvement appears significant when compared to the per capita income of earlier years. In 1998, the per capita Gross National Product (GNP) of Ethiopia, as reported in EDHS 2000, was 100 USD, which declined to 97 USD in 2003 (The United Nations Development Programme, 2005) and then slightly improved to 110 USD in 2005. Despite the progress in economic development, the country has lately experienced a considerable surge of inflation, which rose from about 16.5% in Feb. 2011 to 39% in July 2011, during which time food prices also rose by almost 4 fold, about 47.4% (World Bank, 2012). The implied instability in the macro-economy of the country might have affected progress in the reduction of undernutrition in Ethiopia.

2.4.2. Individual, socioeconomic, demographic and gender related factors

2.4.2.1. Maternal and paternal levels of school attendance

A recent community based study in Nairobi, Kenya reported maternal education as a strong predictor of child nutritional status, particularly stunting (Abuya, Ciera, & Kimani-Murage, 2012). Generally, prevalence of malnutrition among children in Ethiopia tends to be lower as maternal education status increases. Based on evidence from the last three EDHS, school attendance of women improved to 49% in 2010 from 25% and 34% in 2000 and 2005, respectively (CSA & ICF International, 2012; CSA and ORC Macro, 2001; CSA and ORC Marco, 2006). For men, school attendance improved from 48% in 2000 to 57% and 70% in 2005 and 2011, respectively. It is important to note that the highest level of school attainment for most of the women and men doe not exceed primary levels (grades 1-6), with few at the secondary level (grades 6-12) and very few beyond secondary levels. From the figures for women's school attendance in EDHS 2011, though close to half the women achieved some primary education, it was evident that more than 50% of women were still without any formal schooling. The lack of formal schooling may pose potential challenges to knowledge reception capacity and translation of interventions directed to improve maternal and child nutrition, as well as to child caring practices. Poor maternal education may also suppress the outcomes of NNP and other nutrition interventions. This may also partly explain why the rates in the reduction of stunting & underweight for the period 2006-2011 remained almost similar to or poorer than the ones for the period 2000-2005 despite the implementation of HEP and NNP in the 2006-11 period.

2.4.2.2. TFR (Total Fertility Rate)

Whether a child is born in a large family or not contributes to the overall caring practice and nutrition of the child and the mother, particularly in resource poor communities of developing countries. In other words, family size or birth order may affect child nutritional status. Studies have reported a positive relationship between number of siblings and childhood stunting (Kravdal & Kodzi, 2011). In Ethiopia TFR, which is the number of children a woman may have by the end of her childbearing age, has shown a steady decline from 5.9 children in 2000 to 5.4 and 4.8 in 2005 and 2011, respectively (Chadha, 2006; CSA & ICF International, 2012; CSA and ORC Macro, 2001). The recently reported 4.8 TFR of Ethiopia was higher than the 2.2 and 4.5 TFR for Asia and Africa, respectively (UN Data, 2012).

2.4.2.3. Age at first marriage

Teen pregnancy may be one factor that contributes to low birth weight babies and the subsequent increased chance for stunting. A young pregnant girl who is still growing herself is potentially competing for nutrients with the fetus, thereby restricting its growth besides compromising her own nutritional status. One of the factors for teenage pregnancy is early marriage, which increases a woman's fertility and the risk of early exposure to pregnancy (CSA and ORC Marco, 2006). From the EDHS results, the median 'age at first marriage' for those women between 20-49 years has slightly increased to 17.1 years in 2011 compared with 16.4 and 16.5 years in 2000 and 2005, respectively (CSA & ICF International, 2012; CSA and ORC Macro, 2001; CSA and ORC Marco, 2006). Most Ethiopian women tend to get married at an early age. In 2005 EDHS, 66 and 79 percent of women between age 25-49 were married by age 18 and 20, respectively. This was a small improvement compared to 70 and 82.5 percent of the same age group of women in EDHS 2001. In addition, a significant portion of women aged 25-49 years (32% in 2000 and 30% in 2005) started to have sexual intercourse by 15 years of age. This early age of first sexual intercourse, even before marriage, is also an added factor for increased fertility in Ethiopia, and these factors surely have implications for the nutritional status of both the mother and the child. TFR tends to decrease as the level of schooling increases. There is a similar trend with age at first marriage. Women who make it to secondary level tend to delay another five years before they get married compared to those with no schooling. Therefore, education of women plays a key role in the improvement of nutrition during pregnancy and also in improving caring practices for infants and young children, hence better nutrition.

2.4.2.4. Gender mainstreaming and nutrition

2.4.2.4.1. Overview

Ensuring gender equality and empowerment of women was one of the Millennium Development Goals set by all UN participating countries, including Ethiopia (United Nations, 2012). As in many countries in the world, particularly in the developing nations, the male gender dominance (i.e., a patriarchal family structure where males control important resources and earn priorities in anything beneficial) has been a characteristic social dynamic in Ethiopia from ancient times. Though Ethiopia has put in place the necessary policy frameworks to improve the gender disparities that particularly affect women and girls, the Global Gender Gap Index Report ranked Ethiopia 121 out of 134 countries (Hausmann, Tyson, & Zahidi, 2010). The report specifically analyzed the gender gap in four major areas: economic participation and opportunity (as in employment and income from paid work), health and survival, educational attainment and political empowerment. From the ranking, it appears that Ethiopia has been lagging behind in meeting the gender related MDG, that is Goal 3 in the list. About 26% of households were headed by females based on the most recent EDHS survey (CSA & ICF International, 2012). Women are mostly engaged in domestic chores that do not generate cash income, mostly taking care of reproductive work around the homestead and working in the farm, while the men search for off farm activities that generate cash income. Literacy is generally low in Ethiopia, particularly in rural parts, where almost twice as many (69%) women of reproductive age (15-49 years) were reported illiterate compared to only 38% of illiterate male counterparts (CSA & ICF International, 2012). This again points to the gender disparity that exists between men and women in terms of access to formal education.

2.4.2.4.2. Effect on nutritional health

Usually "the face of malnutrition is female" as women are at greater risk of being undernourished, especially in food insecured households (FAO, 2012). From a nutritional health perspective, the degree of women's access to and control over important household resources may determine how well they nourish themselves, their children and the family as a whole because women are the ones mostly responsible for preparing meals for the family (Mucha, 2012; Oniang'o & Mukudi, 2002). The majority of Ethiopia's population live in an agricultural community, residing in rural areas where the patriarchal family-structure is most common. As such, gender disparities in areas of intra-household food distribution are visible—i.e., men are prioritized for meals prepared in the home, while women eat last, and whatever is left over from the rest of the family. This kind of food distribution, which follows the traditional gender roles and relations more than physiological needs, would have a subtle impact on the nutrition of women and young children (FAO, 2010). Ironically, women who usually obtain poor nourishment in the family, do most of the work in the homestead (reproductive role), engage in productive activities (including working on farms and engaging in petty trading to earn income) and also have various social responsibilities in their communities; such multiple roles women have to carry out may predispose them to increased activity (work burden). This further compromises their nutritional health, limiting their ability to efficiently contribute to the healthy functioning of the home environment (Mosse, 1993; Mucha, 2012; Oniang'o & Mukudi, 2002). Greater gender inequality has been reported to co-exist with greater prevalence of undernutrition in women, indicating that undernutrition could be both the cause and/or the result of gender disparities (Mucha, 2012). A gender analysis study in eastern parts of Indonesia, where women and children are known to suffer from marginalization, reported the presence of very high levels of chronic child undernutrition (58% stunting and ~33% underweight) (Ashmad, Giroud, Bait, & Ragalawa, 2012). Clearly, women and children are at greater risks of suffering from malnutrition in places where gender inequality is a significant concern.

In contrast, in places where women experience some level of empowerment (be it in terms of resource acquisition, control over important assets or being able to make important decisions), a positive impact has been shown on the nutrition of children. A study in Nepal reported that women who had access to their own land were better positioned to make final decisions at the household level; children of women who had access to their own land were less likely to be severely underweight (Allendorf, 2007). Another study in Kenya also documented the association between child undernutrition and female ownership/co-ownership of livestock (Jin & Iannotti, 2014). The study indicated children of such women had significantly higher animal source food intake compared with those where only men owned livestock. Hence, empowering women not only improves their own condition but also provides a greater opportunity to improve the nutrition of children (World Bank, 2007).

2.4.2.4.3. Gender equality and development

Women contribute up to almost 50% of agricultural labor—which means women play an important role in food production (FAO, WFP, & IFAD, 2012). The contribution of women, sometimes known as *"the invisible farmers,"* in agricultural productivity and food security is immense but often goes unnoticed and uncredited because of their lower social status compared to their male counterparts. The 2011 FAO annual report on the state of agriculture described in detail the need to close the gender gap and allow women equal access and control over resources should countries succeed in their goal of boosting agricultural productivity, stating that limiting women's access to important resources is a missed opportunity to feed the world and reduce poverty (FAO, 2011). Mosse, in his book, 'Half the World, Half a Chance…' emphasized the need to allow women, who make up half the world, to participate and recognize their important contributions in any development efforts; otherwise, countries risk missing the valuable contribution of women, ending up in a systematic inefficiency of efforts to break the cycle of poverty (Mosse, 1993).

The 2014 global gender gap report ranked Ethiopia far behind many countries (127 out of 142 countries), indicating a continued concern in addressing gender equality. Moreover, Ethiopia has maintained this low ranking over the last decade, without any significant change relative to other countries. Overall, efforts to address gender related concerns in Ethiopia need continued attention alongside the efforts to improve nutritional health of mothers and children.

2.4.2.5. ANC (Antenatal clinic) attendance

Antenatal visits by mothers are not only beneficial in terms of avoiding adverse pregnancy outcomes (pregnancy complications), but they are also an important entry point for delivery of the ENA (essential nutrition actions) messages through the current HEP (health extension program). Data collected on ANC visits in the last three EDHS indicate a gradual improvement (i.e., 27%, 28% & 34% in 2000, 2005, and 2010, respectively) in the proportion of mothers visiting ANC at least once before delivery (CSA & ICF International, 2012; CSA and ORC Macro, 2001; CSA and ORC Marco, 2006). However, it was indicated in the EDHS 2011 report that there is a huge difference between urban (76%) and rural (26%) women. Since ANC is the first of the multiple contact points to deliver ENA, the country has to do considerable work to encourage mothers during pregnancy to visit health facilities during pregnancy where they would potentially receive counseling on nutrition for themselves and their children.

2.4.2.6. Infant and under-five mortality

Infant mortality is taken as a good proxy for a country's wellbeing (Alderman & Berman, 2004) because it reflects the country's socio economic, environmental and health system in which children grow. Taking this into account, reducing child mortality (i.e., infant and under five mortality) by two-third by the year 2015, was set as an indicator for MDG-4 (UNICEF, 2004). For Ethiopia, reducing infant and under five mortality rates has been the target for the HSDP III and HDSP IV. According to the EDHS reports, infant mortality, which is the number of deaths of infants by age one per 1000 live births, has dropped from 112.9 in 2000 to 59 in 2011. The rate was 80 in EDHS 2005 (CSA and ORC Marco, 2006). Similarly, under–five-mortality, expressed as the probability of dying between birth and exactly 5 years of age per 1000 live births, has dropped from 187 in 2000 EDHS to 88 in 2011 EDHS. This figure was 132 in 2005 EDHS report. If Ethiopia maintained this rate of progress, it was predicted that the country would meet the MDG-4 by the end of 2015. Since malnutrition has been the underlying cause for a high proportion of all child deaths in Ethiopia (at least 28% in 2009) (African Union Commission et al., 2014), and, coupled with maternal undernutrition, for one-third of all child deaths in low-income countries (Black et al., 2008), it is expected that infant and under 5 mortality rates are decreasing as the prevalence of stunting and underweight gradually decrease.

2.4.2.7. Maternal Mortality Ratio (MMR)

Improvement in access to quality health services (both antenatal and postnatal clinics) is likely to decrease the prevalence of maternal deaths related to pregnancy complications. Maternal mortality, MMR, is generally expressed per 100,000 live births of children in a given time period and is believed to provide a better estimate of maternal deaths due to obstetric risks as opposed to other causes of mortality. In Ethiopia, MMR is considered for the seven years preceding the specific survey year. Accordingly, MMR appeared to have improved from 871 in 2000 EDHS to 673 in 2005 EDHS (CSA and ORC Macro, 2001; CSA and ORC Marco, 2006). However, the MMR of 676 reported in the 2011 EDHS was not different from the MMR of 673 reported in EDHS 2005 (CSA & ICF International, 2012). In fact, the EDHS 2011 survey indicated that it was difficult to confirm if there has been any change in maternal mortality since the year 2000 because the confidence intervals for all the three estimates overlap. This means that the evidence is weak to determine whether maternal mortality in Ethiopia has declined in the last two decades. However, since stunted children grow up to be stunted adults, which may increase obstetric risks for women during child birth, a decrease in the prevalence of stunting in young children, especially females, will likely improve MMR by reducing obstetric risks associated with poor development of pelvic bones and deficits in height (Black et al., 2008; Ronsmans, Holtz, & Stanton, 2006; Villar et al., 2006).

2.5. Maternal-infant-child nutrition and stunting in Ethiopia

Apart from sanitation and infection, factors such as maternal nutrition prior to pregnancy, during pregnancy and lactation, as well as feeding practices of infants and young children, are major contributors to childhood stunting (linear growth faltering) and associated consequences. The following sections briefly describe nutritional practices during critical periods and how they impact child growth and development, besides their impact on maternal health. Though looking into maternal undernutrition alone has an important implication to maternal health, the focus here is not so much to review the concerns of current maternal nutrition independently as exploring it in the context of its impact on the health and nutritional status of children. This is partly due to the assumption that nutrition specific programs and interventions that aim to reduce child undernutrition also benefit the mother and, perhaps, cannot be done effectively without including the mother in the specific intervention packages. Poor nutritional status during pregnancy and lactation has a clearly negative impact on pregnancy outcome, so combating child undernutrition should consider maternal nutrition.

2.5.1. Maternal undernutrition, dietary practices during pregnancy and lactation and effect on pregnancy outcome

2.5.1.1. Why focus on maternal undernutrition

Despite observed improvements in reducing levels of child stunting/underweight and the fact that Ethiopia was expected to meet the MDG 1 target of ‘halving the rate of underweight’ by 2015 (Figure 2.1), there was still high prevalence of child stunting by the end of 2015. As shown in the 2014 mini EDHS survey, the prevalence of stunting and underweight was 40% and 25%, respectively (CSA, 2014); WHO classifies a prevalence level >30% in child stunting as a concern of high public health significance (WHO Expert Committee on Physical Status, 1995). Besides, this is with the assumption that current progress in the reduction of chronic undernutrition is somehow maintained, which by itself could be a challenge. More work on strengthening the existing strategies of improving maternal and child nutrition may contribute to sustaining current progress and accelerating the reduction of chronic malnutrition among young children from what is anticipated to be accomplished by 2015 (30%, a high prevalence) to moderate prevalence (<30%). As discussed earlier, childhood stunting has consequences associated with short adult stature, lower adult income, reduced economic productivity, lower cognitive development (or lower school attainment) and other health issues later in adulthood.

One of the different ways to tackle the problem of child stunting is to ensure adequate maternal nutritional health at early stages of growth and development. Research evidence suggests that improving maternal nutritional status during or before pregnancy will reduce intrauterine growth restriction, leading to a better pregnancy outcome. This can be measured by reduced prevalence of low birth weight babies at term and, ultimately reduced prevalence of stunting in children under 5 years of age (Bhutta et al., 2008). It has also been shown that an increase in 100g of mean birth weight at term will reduce stunting by 20% by age five (Kusin, Kardjati, Houtkooper, & Renqvist, 1992).

There are documented indications from recent surveys showing the need to improve maternal and child nutritional status in Ethiopia. Some of the most obvious indicators of maternal undernutrition are low BMI in the pre-pregnancy period, lack of adequate weight gain and poor dietary practices during pregnancy and lactation. Poor dietary practice (poor dietary intakes) during pregnancy may be a predisposing factor for chronic energy deficiency, and other micronutrient deficiencies, resulting in an undernourished mother and poor pregnancy outcomes. The first series in Lancet in 2008 reported a prevalence of maternal undernutrition (i.e., a BMI $<18.5 kgm^{-2}$) as high as 20% among mothers in sub-Saharan Africa and other Asian countries (Black et al., 2008). The second series in 2013 also indicated a modest decline, but rates remained high above 10% in the two developing regions (Black et al., 2013). WHO categorizes prevalence >20% as a concern of high public health importance and a serious situation (WHO, 1995).

One of the implications of low maternal BMI is that it increases the risk of intrauterine growth restriction (IUGR) of unborn babies, which, in turn, results in low birth weight (LBW) in term babies (Black et al., 2008). A study in Vietnam showed that mothers with low BMI are 20% to 40% more likely to give birth to LBW infants, particularly when mothers fail to gain adequate weight during pregnancy (Ota et al., 2011). Black et al. (2008) also argued that every year about 13 million children are born with IUGR around the world, posing a risk to child growth and survival. The third paper in the Lancet series of maternal and child undernutrition reported a systematic review of studies which argued that it was possible to reduce intra-uterine growth restriction by up to 32% when the energy and protein intake of mothers was improved during pregnancy (Bhutta et al., 2008; Kind, Moore, & Davies, 2006; Kramer & Kakuma, 2003). Studies of 200 pregnant women from rural Guatemala showed that foetal linear growth and infant length at birth were significantly predicted by maternal weight gain from the first to second trimester of pregnancy, unlike weight gain from the second to third trimester of pregnancy (Neufeld, Haas, Grajeda, & Martorell, 2004). These also re-enforce the fact that maternal nutritional status before and during pregnancy is vital for combating intrauterine growth restriction of unborn babies and the associated risk for stunting.

2.5.1.2. Levels of maternal undernutrition and dietary practices

Adequate nutrition in rural Ethiopia is a continuing challenge for women. Even when the food is available, women are at greater risk of being malnourished because of their multiple gender roles: including their reproductive responsibility in bearing and raising children, their need to take care of household chores, and their productive responsibility of working on farm, as well as carrying out many social responsibilities. These multiple responsibilities add considerable work-burden on women, increasing their risk of being malnourished (FAO, 2012). Women are also at a greater risk of being malnourished because of their physiological status: their menstrual cycle causes constant blood loss which, without good nutrition, may lead to anemia; being pregnant or lactating also demands increased nutritional requirements.

Diets in rural Ethiopia are mostly starchy-stapes with little or no animal source food consumption, except on special occasions. A study among pregnant women in south Ethiopia documented very high levels of zinc and protein deficiency based on weighed food record data and through biochemical analysis of plasma zinc and albumin (Abebe et al., 2008). A supporting study in the same community among the same pregnant mothers who did not consume cellular animal products also documented anemia (up to 29% anemic, 33% depleted iron store, 13% iron deficiency anemia) (Gebremedhin et al., 2011; Gibson et al., 2008). In the study by Gibson et al. (2008), among other factors, plasma zinc was the strongest positive predictor of anemia—perhaps indicating the quality of the diet the women were on. A very high level of zinc deficiency has also been documented in another study that examined serum zinc and determinants of serum zinc, where hemoglobin was shown to have a positive association while frequency of coffee consumption had a negative association with serum zinc (Gebremedhin et al., 2011).

The study by Gebremedhin and colleagues also has shown that much of the variability in serum zinc status can be explained by dietary factors such as animal source food consumption, dietary diversity, food insecurity and whether mothers were predominantly from maize or *Enset* staple diets. Based on the EDHS report, prevalence of anemia among reproductive age women has declined from 27% in 2005 to 17% in 2010, but still a high proportion of women were anemic. It is important to note that iron deficiency can exist without women being anemic, and the 17% consisted only of those whose hemoglobin levels were below 11-12 g/dl.

Results from a recent nutritional and health survey indicated that large proportion of pregnant Ethiopian women (75% urban and 83.5% rural) consumed meals that were the 'same as' or 'less than' 'usual' during their pregnancy (EHNRI, 2010). The report also showed that more than half of reproductive age women did not know foods that are rich sources of iron (57%) and vitamin A (51%); and close to 40% of these women had a dietary diversity score of 2 or less (indication of poor dietary quality). These poorer dietary practices and limited knowledge of nutrition were also reflected in the existence of high maternal undernutrition as the EHNRI (currently known as EPHI–Ethiopian Public Health Institute) nutrition baseline survey reported 26% of reproductive age women in the Southern Region and 29% at the national level had a BMI of <18.5 kgm^{-2}, a manifestation of chronic energy deficiency or underweight in adults. This high prevalence of low BMI has not changed from what it was in 2005 EDHS survey (27%). A similar finding was also observed in 2011 EDHS, indicating the need to strengthen and intensify nutrition specific and nutrition sensitive interventions in this segment of the population.

2.5.2. Stunting and child feeding practices

Since linear growth faltering among children under 5 years of age peaks and is completed between 6-24 months (Victora et al., 2010), interventions in the area of child feeding practices during this period have been recommended as one of the key strategies to alleviate the burden of stunting and associated mortality and morbidity. The following two sub-sections will briefly discuss recommendations to child feeding practices and their association in terms of their contribution to childhood stunting.

2.5.2.1. Breastfeeding practices

Appropriate breastfeeding practices include initiation of breastfeeding within one hour after delivery, the giving of colostrum (first milk), breastfeeding on demand and at least 8 times within a 24 hour period, exclusive breastfeeding for the first six months of life and continued breastfeeding until at least 24 months of age with complementary foods starting at 6 months of age (UNICEF et al., 2010). UNICEF et al. (2010) emphasized that ensuring wide coverage of exclusive breastfeeding alone, i.e., only breast milk and no other solid or liquid food for six months, would spare the lives of 1.2 million children globally every year. Continuing breastfeeding at least until 24 months of age along with the addition of other foods would improve the growth of millions of children.

While breastfeeding has not been shown to have any direct effect on reducing stunting, there has been ample evidence showing a significant reduction in mortality and morbidity in neonates and infants that were breastfed (Bhutta et al., 2008; Jones, Steketee, Black, Bhutta, & Morris, 2003; Victora et al., 2000).

According to Table 2.3, despite the WHO recommendation for exclusive breastfeeding of infants <6 months, a proportion of infants, as high as 62% - 68%, in Ethiopia were not exclusively breastfed by age 4-5 months. Nearly half of all infants <6 months of age were not exclusively breastfed. More than one in four infants still received pre-lacteal feeds that may predispose the infant to infectious diseases and risk of diarrhoea. In addition, one in two children was not put to the breast within one hour after birth. Early initiation of breastfeeding is beneficial both for the mother and the child as it stimulates the release of hormones that help in contraction of the uterus and minimize post-partum bleeding. The hormones are also responsible for the production of milk (CSA & ICF International, 2012).

Since the first milk (colostrum) contains antibodies, the giving of colostrum and early initiation of breastfeeding is vital for the health and survival of infants and young children. The information presented in Table 2.3 indicates the need to continue to educate and promote appropriate infant and young child feeding practices in Ethiopia. These findings are supported by a recent study that looked into breastfeeding practices of mothers in South West Ethiopia, where more than a 75% prevalence of suboptimal breastfeeding practices was documented (Tamiru, Belachew, Loha, & Mohammed, 2012). Tamiru and colleagues also argued that most mothers still did not understand the importance of timely initiation of breastfeeding, the giving of colostrum and exclusive breastfeeding.

2.5.2.2. Complementary feeding practices

The period of complementary feeding refers to the time from 6 months until about two years of age when a child is introduced to solid and semi-solid/soft foods. It is the time span during which linear growth faltering is most prevalent and also the period when the process of becoming stunted is almost completed (Victora et al., 2010). This makes the first two years of life very critical for any intervention that aims to avert growth faltering and associated

Table 2.3 Trends in the prevalence (%) of selected infant and young child feeding practices in Ethiopia based on various national surveys [a]

Indicators	Level of report	EDHS 2000	EDHS 2005	EHNRI 2009/10	EDHS 2011
Colostrum (first milk)	National	42.5	45.3	60.2	na
	Regional [b]	39.0	39.3	na	na
Pre-lacteal feed [c]	National	na	29	31.8	27.1
	Regional	na	15.4	na	10.4
Initiation of breastfeeding within 1 hour of birth	National	51.8	69.1	45.5	51.5
	Regional	61.5	71.4	na	66.5
Exclusive Breastfeeding (EBF) at age 4-5 months	National	38.1	31.6	36.3	31.8
	Regional	na	na	na	na
EBF in <6 months of age	National	62.3 [d]	49	51.4	52
	Regional	na	na	na	na
Introduction of complementary food by age 6-8 months	National	43.0 [e]	50.0	na	48.4
	Regional	na	na	na	na
Minimum meal frequency [f]	National	na	na	75.2	47.9
	Regional	na	na	na	48.9

EDHS= Ethiopian Demographic and Health Survey; EHNRI= Ethiopian Health and Nutrition Research Institute; na= data not available;
[a] Data were taken from the three available Demographic and Health Surveys (conducted five years apart at a national level) and a nutrition baseline survey report by EHNRI;
[b] Refers to the Southern Nations, Nationalities and People's Region (SNNPR)
[c] Anything other than breast milk given to the infant in the first three days after delivery
[d] Figure represents those exclusively breastfed for up to 4 months of age rather than up to 6 months.
[e] Figure represents those introduced to CF by age 8-9 months (expected to be higher as the children grow older and being exposed to more solid foods)
[f] Minimum meal frequency for breastfed infants is receiving solid or semi-solid foods at least 2 times for infants 6-8 months and 3 times for infants 9-23 months in a day (WHO, 2008a);

consequences in young children. In a review of earlier research, nutrition education surrounding complementary feeding in food secured populations was shown to improve linear growth in young children (Bhutta et al., 2008). The review also added that increment in mean height-for-age z-score was also observed for food insecured populations that received food supplements with or without nutrition education.

Earlier studies that looked into factors dictating human growth processes in infancy, childhood and puberty have shown that growth in infancy and early childhood is nutrition driven, while growth in the later stages are hormone driven (Tse, Hindmarsh, & Brook, 1989). It was also reported that growth at the early stage of infancy is simply "a post-natal continuation of fetal growth" (Karlberg, 1989). This adds further evidence to the importance of creating a healthy nutritional environment at early stages of a child's growth. An observational study in Ethiopia that considered the quality and quantity of diet in early childhood reported that the incidence of stunting was higher in infants and young children whose diets were poorer, in terms of quantity and quality, than those who consumed a better quantity and quality of food with more frequency (Umeta et al., 2003). A recent study in rural communities of Southern Ethiopia also reported higher rates of stunting among infants from 6-8 months (43%) and 9-23 months (39%) compared to 0-6 months (26.6%) (Tessema et al., 2013). The study also documented very poor compliance (14.4%) to WHO recommended optimal child feeding practices and that children who started complementary feeding too early (i.e., before 6 months) or too late were more likely to be stunted than their counterparts who started complementary foods at 6 months of age. An earlier, similar child feeding study in Southern Ethiopia also documented higher levels of stunting and low adherence to the WHO child feeding recommendations, where solid/semi-solid diets were of low micronutrient content and below minimum diversity and meal frequency recommendation (Gibson et al., 2009).

Appropriate complementary feeding of children, according to WHO feeding recommendations, with control of infectious diseases, has been promoted as one of the strategies to combat growth faltering and associated ill-health consequences in young children (Bhutta et al., 2008; Black et al., 2008). As important as this may be, if factors in the early pregnancy and infancy are not well addressed, investments in complementary feeding of children may not bring significant improvement in growth. A recent RCT study in multiple developing countries looked into the contribution of 30-45 g of meat and an equal caloric multi-micronutrient-fortified cereal, supplemented to children of age 6-18 months, in reducing stunting and improving micronutrient status (Krebs et al., 2012). Krebs et al. reported the absence of significant differences in either linear growth velocity or reduction of stunting between the 'meat' and fortified 'cereal' supplemented groups and argued that interventions should be all-rounded and consider pre-natal and early infancy periods.

One of the strategies to combat undernutrition by improving diets of women and children is ensuring diversity in the diet, as well as food security. Locally produced crops such as pulses hold potential to improve diet quality and also contribute to food security in resource poor settings, owing to the multiple roles pulses have. The next sections explore the nutrition and other benefits of pulses and the potential for improving nutrition of women and children in Ethiopia.

2.6. The role of pulses in human nutrition and food security

Pulse crops come under the family of *Leguminosae* and include different types of dry beans, peas, chickpeas and lentils. They have vital roles in human nutrition because of their high protein content; hence, they serve as alternative protein sources, particularly when animal source foods are not readily available (Ofuya & V., 2005). They complement foods from cereals for energy and protein, as well as serving as good sources of micronutrients. Consumption of pulses is global and is higher in tropical and sub-tropical regions of the world with limited access to animal source foods (Ofuya & V., 2005). The nutritional value of pulses in human diets is also considerable in terms of energy provision. The review paper by Ofuya and Akhidue (2005) indicated that the energy content of pulses—collective contribution of carbohydrates, proteins and fats—generally ranges from 300 (lentils) to 540 (peanuts) in Kcal/100g, which is equivalent to that of cereal grains. In addition, pulses contain B vitamins like folate, niacin and thiamin, as well as key minerals such as iron and zinc; they are low in saturated dietary fat and are very good sources of dietary fiber (Pulse Canada, 2012).

Though pulses can be good source of energy, they are also useful to manage blood glucose levels as they take longer to release their sugar (have a low glycemic index) and do not cause sudden rises in blood glucose levels, a condition particularly beneficial for diabetic persons (Rizkalla, Bellisle, & Slama, 2002). Rizkalla and colleagues also mentioned that the very low glycemic index of the carbohydrate from pulses goes beyond treating diabetes mellitus. Pulses increase the feeling of satiety in the post ingestion periods and thus control dietary intakes, beneficial in the prevention of overweight and obesity. In addition, the high fiber they contain is beneficial for gastrointestinal health by reducing transit time in the colon and lowering constipation, which ultimately may contribute to the reduction of colon cancer (Ofuya & V., 2005). Dietary fiber also has blood cholesterol lowering effects since it has the ability to bind cholesterol in the digestion tract. These are some of attributes of pulses constituting their important role in the human diets.

2.6.1. Pulses, alternative source of protein and energy

Pulse grains including peas, lentils, dry beans/broad beans and chickpeas are of a high protein profile, containing from 21 to 26 percent protein, which is about twice the amount of protein in cereal grains and many times the amount of protein in root crops (Ofuya & V., 2005; Pulse Canada, 2012, 2016). In addition, foods that contain proteins from multiple plant-based diets provide good quality protein because of the complementary effects of amino acids from different sources. The improvement in the quality of protein is due to the fact that legumes generally lack an essential amino acid called methionine but have higher amounts of the amino acid lysine, whereas cereals have the opposite attributes; hence, combining pulses and cereals increases the quality as well as the quantity of protein from these sources (Ofuya & V., 2005; Pulse Canada, 2012). Pulses can also supply a nearly equivalent amount of energy as cereals, but a higher proportion of carbohydrates and very low fat.

2.6.2. Pulses, sources of micronutrients (iron & zinc)

Micronutrient deficiency, also known as "hidden hunger," is a common problem, particularly in developing counties. An estimated 40% of the world's population, of whom women and young children experience a higher share of the burden, are affected by various micronutrient deficiencies, including vitamin A, iron, zinc and iodine, and most of these affected groups live in developing countries (Micronutrient Initiative (MI), 2009; Thavarajah, Thavarajah, Sarker, & Vandenberg, 2009). Anemia affects an estimated 1.6 billion people globally, and half of this is attributable to iron deficiency (HarvestPlus, 2016; Pfeiffer & McClafferty, 2007). Iron deficiency anemia has been associated with poor dietary practices, growth and cognitive performance in children, as well as poor physical productivity in adults; the highest proportion of affected population resides in Africa (HarvestPlus, 2016; McLean, Cogswell, Egli, Wojdyla, & de Benoist, 2009). Iron deficiency in mothers has also been reported as a risk factor for low-birth-weight babies and an increased risk for maternal as well as perinatal mortality (Black et al., 2013). Staple foods like rice, wheat, maize and root crops support the large majority of the population in developing nations. For example, a cereal crop such as rice takes the largest share as a source of energy but is a very poor source of the micronutrients iron and zinc (Thavarajah et al., 2009). The important role of zinc in growth has been discussed in Section 2.2.2. Thus, pulses, given their widespread use with cereals, have been referred to as potential grains for food-based approaches to combat micro-nutrient deficiencies in developing countries.

The study by Thavarajah et al. also indicated that some pulses, like lentils, carry a huge potential for iron and zinc bio-fortification and thus, for combating deficiencies in populations. Zinc and iron have been reported to have demonstrated effect on linear growth. A supplementation study on iron and zinc together showed a significant improvement in linear growth in stunted children suffering from low haemoglobin levels (Fahmida et al., 2007). Furthermore, since supplementation and fortification strategies for combating micronutrient deficiencies require stable infrastructure and economic capacity for their sustainability, dietary modification (diversification) has been suggested a more feasible strategy to tackle the issue in developing countries (Gibson, 2006).

2.7. Pulses in Ethiopian diet: Production and consumption

2.7.1. Ethiopian diet, brief overview

Ethiopia is an ancient nation and home to more than 80 ethnic groups with a unique topographical and cultural diversity including food traditions. Christianity and Islam are the major religions in the country with half the population being Orthodox Christians, about one-third Muslim and about 18% Protestant Christians (CSA & ICF International, 2012). Though much is not known (documented) about how or when certain food crops started to be cultivated in Ethiopia, the two dominant religions of Ethiopians (Christianity and Islam) may have influenced the type of diet.

There are certain dietary restrictions common to both Orthodox Christianity and Islam; a good example is pork, which is considered 'unclean' in the two dominant religions the country. In addition, there are a number of fasting days throughout the year, particularly in Orthodox Christians, which place various levels of dietary restrictions on particular days of the week and seasons of the year. The most common fasting days of the week are Wednesdays and Fridays, when followers of the faith avoid consumption of any animal source food, including any dairy, flesh meat, or any poultry except fish (Selinus, 2010; The Ethiopian Orthodox Tewahedo Church, 2003). Meat/meat products are usually expensive to the majority of the poor and are consumed only on major holidays during the year—they are not part of an everyday-meal. Instead, plant-based food is what the majority of the population depend on (Selinus, 2010). The early report by Selinus also documented that the most common plant-based foods are coming from cereals, such as teff (native to Ethiopia), corn, sorghum, wheat and millet; legumes, such as chickpeas, field peas, lentils and broad beans; tubers, such as potatoes and sweet potatoes; vegetables, mostly red onion and kale; various spices; and oilseeds. Fruits are not produced in large quantities; some examples are lemons, bananas and oranges. Milk from cows, meat, fish (where available), chicken and eggs are common animal source foods as well.

The national dish of Ethiopia is *Injera* with *wot. Injera* is a flat pancake-like leavened bread prepared mainly from leavened *teff* flour, but it can also be made from the other cereals. *Wot* is the stew or sauce made from split legumes or legume flours and various spices which is placed on top of the *Injera,* along with other vegetable dishes (Teklehaimanot, 2015). The most common Ethiopian spices is called *berbere* (a hot spice made from a mix of ground red chili pepper and several other spices). Traditionally Ethiopians eat from a common plate and use their hands to eat, as opposed to using forks and knives.

Another very notable indigenous food crop, most common in the southern and southwestern parts of Ethiopia, is the *Enset* plant, *Enset Ventricosum*, (also called false banana, Abyssinian banana or Ethiopian banana). Along with corn, Enset is a major staple in southern parts of Ethiopia contributing up to 90% of the energy for the smallholder farming communities (Abebe et al., 2008; Gibson et al., 2008; Maxmen, 2014). *Enset* is an important food security crop as it is drought resistant, thereby preventing hunger. This food can be stored for a lengthy period. The plant provides shade for other crops and its heavy root protects the soil from erosion while its long leaves provide nutrients to the soil, improving the soil quality without need for intensive maintenance (Nierenberg, 2013). Despite the agro-ecological contribution of *Enset*, some experts from IFPRI argue that *Enset* is only good for home consumption, and smallholder farmers need to focus on farm practices that increase yield—something they can sell to generate income and alleviate poverty (Maxmen, 2014). The edible portion of the plant is the pseudostem, which is fermented and processed to make a bread called *'kocho'.* The root is also boiled and eaten like a potato. Nutritionally, *Enset* is poor in protein but provides energy and research in *Enset* consuming communities, specifically on pregnant women, showed a significant amount of vitamin B-12, both in the diet and in the blood serum, which probably comes from the microbial activity during the fermentation process as part of preparation of '*kocho*' (Gibson et al., 2008).

Overall, the Ethiopian diet tends to be predominantly plant-based, with starchy staples like cereal grains, roots, tubers, *Enset* and legumes predominating.

2.7.2. Pulses in the Ethiopian diet

Pulses have a long history in Ethiopian agriculture and food culture. They play multiple roles in the life of the smallholder farmer in Ethiopia. These roles include: pulses' significant contribution to food security (constitute 15% of the average Ethiopian diet), their function as alternative sources of protein when meat/fish/poultry are not affordable, and their particular importance as the largest source of protein for about 40% of Ethiopia's Orthodox Christian population during fasting seasons (IFPRI, 2010). The IFPRI report also emphasized the contribution of pulses as profitable sources of income for smallholder farmers compared to cereals like wheat, barley and teff; however, this benefit might not have been fully realized as most of the produce is consumed on the farm. In addition, pulses, through their nitrogen fixing ability, improve soil fertility, which in turn reduces expenses for artificial fertilizer for cereals crops during the following production year. Pulses are also the third most important export crop in Ethiopia following coffee and oilseeds.

The following subsections of the literature briefly review the most commonly grown pulses in Ethiopia, in which geographic regions they are grown, and the level of production/the production capacity. A subsequent section briefly discusses the main challenges that exist in connection with production and consumption of pulses in Ethiopia.

2.7.3. What? Where? How much?

What: Commonly grown and consumed pulses: Ethiopia has an economy where agriculture directly supports the livelihood of about 85% of its population and where ~45% of the GDP is accounted for by agriculture (Ethiopian Export Promotion Agency, 2004; IFPRI, 2010). Pulse crops have been an integral part of Ethiopian smallholder farming communities for many years. Being higher-value crops compared to cereals, pulse crops provide cash-income; in addition, they provide alternative sources of protein in the diet and contribute toward food security (Ethiopian Export Promotion Agency, 2004). Pulse crops are the second most important element in the Ethiopian diet through the provision of alternative protein sources and serve as important complements to cereal consumption.

The most commonly grown types of pulse crops in Ethiopia include horse/faba beans (*Vicia faba* L), chickpeas (*Cicer arietimum* L.), haricot beans (*Phaseolus Vulgaris* L.), lentils (*Lens cultinaris* Medik.), dry peas (*Pisum Sativum* L.) and vetches (*Vicia sativa* L.) (Ethiopian Export Promotion Agency, 2004). However, there are about twelve types of pulses grown in both highland and lowland parts of the country (IFPRI, 2010). In addition to the most common types mentioned, grass pea (*Lathyrus sativus* L.), field pea (*Pisum Sativum L.*), fenu greek (*Trigonella foenum-graecum* L.), lupine (Lupinus albus L.), soya bean (*Glycine Max*, L), cowpea (*Vigna Unguiculdata*), pigeon pea (*Cajanum Cajan* L.) and mung bean (*Vigna radiata*) are also grown in different parts of Ethiopia.

Where: Parts of the country producing and consuming pulses: Most of the pulse crops grown in Ethiopia are generally categorized as either highland or lowland pulses. The ones grown in the cooler highlands of Ethiopia include faba bean, field pea, chickpea, lentil, grass pea, fenugreek, and lupine, whereas haricot bean, soya bean, cowpea, pigeon pea and mung beans are pulses commonly grown in the warmer lowland parts of the country (IFPRI, 2010).

According to the IFPRI 2010 report, pulse production was highly concentrated in the Amhara and Oromiya Regions, where about 92% of chickpea, 85% of faba bean, 79% of haricot bean, and 78% of field pea production came from (IFPRI, 2010). Among the four most commonly grown pulses in Ethiopia (faba bean, field pea, chickpea and haricot bean), the Amhara Region is the leading producer of all except the field pea, for which the Oromiya Region takes the lead. However, a recent report that showed time series data indicated that production and productivity of the major pulses including lentils have increased over the last 10 years in SNNPR (CSA, 2015a). In particular, productivity growth rates of faba bean, field pea, chickpea and lentil were the highest in the SNNPR, followed by the Oromiya and Amhara regions (CSA, 2015a). The report also showed that among all the regions, the productivity growth rate of the lentil was the highest over the last 10 years.

How much: production capacity (compared to other staples): Cereal crops (mainly *teff, maize, wheat and sorghum*), being the major food crops in Ethiopia, occupy 78.23% (8.8 million hectares) of the grain crop area, accounting for 84.69% (144.96 million quintals) of the total grain crop production (CSA, 2009). The trend was also similar in the recent national report (CSA, 2015b). Following cereal crops, pulse production is widespread throughout the country occupying 13% and 13.26% of Ethiopia’s cropland area in 2008 and in 2015, respectively (CSA, 2009, 2015b). According to the 2009 CSA (Central Statistical Agency) report, the total area of cropland covered by pulses has slightly increased to 14.14% (1.58 million hectares), accounting for 11.48% (19.6 million quintals) of total grain-crop production in the country. The same report also indicated faba beans, haricot beans and chickpeas account for 4.07% (~6.9 million quintals), 1.93% (3.29 million quintals) and 1.82% (3.1 million quintals) of total grain production, respectively.

2.7.4. Challenges in production and/or consumption of pulses

Despite the many beneficial attributes of pulses in the areas of human nutrition, agricultural productivity (i.e., natural soil fertilization through nitrogen fixation) and their contribution as sources of income (cash-crops), there are certain challenges that may hinder pulse utilization from their full potential. Some of these challenges include economic access, productivity or availability, as well issues with processing and preparation, as briefly described below.

2.7.4.1. Economic access

Pulses in general are high value 'cash' crops compared to cereal grains. Of all the pulse crops produced in Ethiopia, the lentil is the most consumed and most expensive pulse crops, yet it is not one of the four most commonly produced pulses (Ethiopian Export Promotion Agency, 2004; Seyoum, Dorosh, & Asrat, 2011). The lentil is mostly produced by smallholder farmers who largely apply traditional ways of production without utilizing modern farm inputs (Bekabil, 2014; Mulugeta, 2009).

2.7.4.2. Yield /availability of better performing varieties

Despite the fact that pulses have been a vital component of the Ethiopian diet by complementing foods from cereals, pulse production is below potential for the country. A report by IFPRI, referencing farm research on experimental plots, indicated that the current productivity of some pulses crops can be increased from more than double (for example, the chickpea) to triple in the cases of the faba bean, given appropriate farm inputs and practices are applied (Ali, Khan, & Randhawa, 2004; IFPRI, 2010). The national average production of lentils has been fluctuating between 509 kg/ha in 2002 to 876 kg/ha in 2008, while the productivity in research and farmers' fields has been as high as 1400 to 5000 kg/ha and 900 to 3000 kg/ha, respectively, indicating a significant potential to increase yield (Bekabil, 2014). Some of the main challenges facing lentil production in Ethiopia include biotic factors (such as rust and wilt/root-rot complexes) and other factors, such as water-logging, drought, poor management practices and lack of improved technology (Mulugeta, 2009). Some of these constraints were also reported as contributing factors for under-potential production of other pulses. The major challenges identified as being associated with poor pulse productivity include inadequate or no use of chemical fertilizers, use of poor cultivars/varieties and poor agronomic practices (IFPRI, 2010).

The use of improved varieties, with recommended farm practices, is very limited in Ethiopia despite the fact that a number of better performing varieties have been released by local pulse research programs in the country (IFPRI, 2010; Mulugeta, 2009). In recent years, the USAID, through the scientists at the International Crop Research Institute for Semi-Arid Tropics, have introduced a better performing chickpea variety—i.e., of short maturity and having drought and disease resistance. The introduction of better performing chickpea varieties was part of the effort to expand Ethiopia's economy because chickpeas are needed not only locally but also in the international market as ingredients to make hummus (Nukala, 2012). The new variety, which was developed through traditional crossbreeding, resulted in the increased production of chickpeas by 15% between 2010 and 2012.

In general, productivity has been reported as being below potential and the country exports considerable amounts to generate foreign currency, which may affect availability and price of pulses for local consumption. Poor distribution due to lack of adequate infrastructure, poor market access and cost of transportation may also add to the challenges for optimal utilization of pulses locally.

2.7.2.3. Issues in processing and preparation

There is a scarcity of documented material as far as issues with processing and preparation of pulses in Ethiopia is concerned. One of the perceived barriers to pulse consumption is the fact that pulses cause flatulence (the passing of gas). Preliminary studies in pulse producing areas of rural Ethiopia reported low consumption of pulses and that flatulence (generally considered 'inappropriate/ embarrassing' in Ethiopian culture) has been mentioned as one of the factors limiting consumption (Kebebush, 2011; Roba et al., 2015). However, a study that investigated the consumption of pulses and their contribution to flatulence, abdominal discomfort and overall gastrointestinal function reported only a minimal perceived effect on flatulence and abdominal discomfort for people who consumed pulses for 28 days compared to the control participants who stayed on a potato diet (Veenstra et al., 2010).

Since preparation of pulses mostly involves soaking for long hours (usually overnight), boiling, roasting and/ or grinding, they have implications for fuel and water consumption, particularly in areas where water and sources of fuel are scarce. Since women are mostly responsible for collecting water and firewood, and for household food preparation in most rural and urban communities, processing and preparation of foods from pulses may have a “gender dimension” in terms of putting an additional work-burden on women. This could also be an issue that may, in some way, limit the utilization of pulses at the household level.

Traditionally, pulses are considered ‘the meat of the poor’ or ‘poor person’s diet’ in Ethiopia (Getenesh, Addisalem, Afework, Whiting, & Henry, 2014). As positive as this may sound, it may also send a negative message, as though pulses are foods one would consider eating only if one is poor. This notion may compromise or limit the utilization of pulses by the segment of the population that, presumably, is able to afford animal source foods. However, both the poor and the rich could utilize the health benefits of pulses, besides the additional advantage of benefiting those in resource poor settings with affordable protein sources. Thus, increasing awareness of the nutritional importance of pulses for all segments of the population may be beneficial to bring changes in attitudes.

2.8. Interventions (in pulse agriculture) aimed at improving nutrition in mothers and children

Increasing numbers of reports and publications in recent years illustrate the momentum of various international communities to link agriculture with nutritional outcome of populations. It is not uncommon to come across phrases, such as ‘*linking agriculture to nutrition,’ ‘making the agriculture work for nutrition,’ ‘shaping the agriculture for nutrition impact,’ ‘leveraging agriculture for nutrition,’ ‘linking agriculture to nutrition and health,’* or *‘making the agriculture pro-nutrition.’* These phrases and words indicate a major move towards increasing nutrition-sensitive agriculture in the global agricultural community and the willingness for multisectoral collaboration for the common goal of making agriculture work for nutrition and health.

Alongside this movement, there have been some efforts to document evidence of previous agricultural interventions (including fisheries, livestock production, home-gardening, irrigation projects) having impacted the nutrition or nutritional status of children or other household members. Reviews of the available literature by the World Bank have shown that agricultural interventions in the past have not always translated to nutritional benefits or have not shown a clear and measureable impact on nutritional outcomes of the population (World Bank, 2007). Another systematic review of several agricultural interventions based studies, between 1990 and 2010, did not find strong evidence of such interventions impacting the nutritional status of children; however, the study argued that the lack of nutritional impact from these interventions was methodological rather than from the interventions themselves (Masset et al., 2012). These results were supported by the second *Lancet* series of publications, in which effects of targeted agricultural programs in improving nutrition were reported "inconclusive," except for the orange-flesh sweet potato, which appeared to have a small effect on vitamin A status for those in the intervention group (Ruel, Alderman, Maternal, & Child Nutrition Study, 2013). A more recent review publication that sought evidence for the agricultural impact on nutrition reported that such evidence was still "disappointingly scarce" (Webb & Kennedy, 2014). Similarly, this study also indicated that the poor relationship between agriculture and nutrition and the lack of empirical evidence of impact, despite the obvious potential, should be attributed to weak study designs. As such, the lack of evidence should not be equated to 'absence of impact.'

Nevertheless, some reports, such as one by IFPRI (International Food and Policy Research Institute), have indicated the potential to reduce child undernutrition and stunting in Tanzania through creation of a 'pro-nutrition' agricultural environment which aims at improving income and productivity (Ecker, Mabiso, Kennedy, & Diao, 2011). A study evaluating the economic impact of producing and consuming improved varieties of mung bean among Pakistani women with high prevalence of anemia, reported a beneficial effect of mung bean agriculture and suggested production of improved varieties of pulses and vegetables for nutritional impact (Weinberger, 2005). Another study from Tanzania that attempted to document agricultural impact found limited evidence but suggested that strengthening and closely mobilizing existing and future agricultural interventions would hold strong potential to impact nutrition (Ecker et al., 2011). A participatory intervention project in Northern Malawi that attempted to link agricultural practices and nutrition along with nutrition education reported a positive impact of agriculture on child growth and nutrition (Bezner Kerr et al., 2011).

2.9. The need for integrating community-based nutrition education with agricultural practices

Up until recently, nutrition has been the neglected, not fully understood, least acted upon and underfunded corner of the Millennium Development Goals (World Bank, 2007). Moreover, the link between diet and health, as well as the link between agriculture and nutrition or nutrition security, is misunderstood or poorly understood by many people (McNulty, 2013; World Bank, 2007). The Nutrition Education Group from FAO headquarters argues that even though nutritional adequacy or good nutrition is dependent on availability and access to sufficient, safe and good quality foods, increasing food security alone is not sufficient to improve nutritional status (McNulty, 2013). According to the World Bank report and a systematic review of several agricultural intervention studies, improvements in agricultural productivity did not necessarily translate to improvement in nutritional status (Masset et al., 2012; World Bank, 2007). Despite the obvious direct relationship between food production and consumption, the connection between the two entities (i.e., increased production leading to improved availability, access and improved dietary intake) is much more complex in practice. This is partly due to the awareness, attitudes and practices of people that determine eating habits and, ultimately their nutritional health (McNulty, 2013). The FAO team also asserts that since attitude and practices can be influenced by education, appropriate nutrition education that focuses on eating the right food, and not just more or less food, would contribute towards improving nutritional health.

A recent FAO commissioned country survey in Ethiopia revealed a general lack of nutrition education and nutrition education training in the country (Ersino, 2011). The survey, involving extensive expert consultation with key nutritionists and nutrition educators in the country, has indicated a demonstrated need for nutrition educators and nutrition education training in Ethiopia.

pulse crops, as described earlier, have always been important components of smallholder agriculture and household diets in Ethiopia (Ethiopian Export Promotion Agency, 2004; Mulugeta, 2009). In addition to complementing cereal foods, pulses, being higher value crops than cereals, have been important sources of cash income, as well as a means for improving soil fertility through crop rotation practices.

However, despite their important roles, production of pulses has remained very traditional with an 11.48% contribution to the total grain-crop production in the country (CSA, 2009). Recent studies in some rural communities of Ethiopia have also shown the important contribution of pulses in the diet, while at the same time indicating the need for appropriate nutrition education to optimize the benefit of pulses as alternative sources of protein and micronutrients, as well as to change the attitude/perception that ‘pulses are the meat of the poor’ (Mesfin et al., 2016; Roba et al., 2015). The notion that ‘pulses are the meat of the poor’ may have the potential to send a message that pulses are optional foods only to be consumed in the absence of animal source foods, or pulses are foods for poor people only and/ or are of inferior quality nutritionally. The studies have also shown that some communities were consuming just the pulses alone, i.e., without combining cereals. Not combining pulses and cereals may undermine the complementary effect of pulses in improving the protein quality of cereals.

2.10. Theories that can be used to guide nutrition education

2.10.1. Brief overview of common models and theories in nutrition education

Through the years, several theories and models have been developed to guide health education and health promotion, which , in turn, sought to bring changes in desirable health behavior at the individual, group, community or organizational levels (Glanz, Rimer, & Viswanath, 2008). Nutrition science (even more, the field of nutrition education) is a relatively young science. As such, it does not have its own dominant theory or model but borrows mainly from the social sciences (Achterberg & Miller, 2004; Lytle, 2005). Some critics have questioned the appropriateness of using scientific methods to evaluate nutrition-related behavioral outcomes by applying theories from the behavioral science, the pretext for this being that human behavior is too complex to be predicted the way things are in the natural science world (Buchanan, 2004). However, Lytle argued that, despite the challenge to sufficiently predict behavioral outcomes, nutrition educators have benefited and continue to benefit from using behavioral theories to effect desirable nutrition behavior in individuals and communities (Contento, 2008).

Sherman & Muehlhoff have divided nutrition education models into two broad categories: “old models” and “new models” (Muehlhoff & Sherman, 2016). They grouped “information delivery” and KAP (Knowledge, Attitude and Practice) under the old models of nutrition education and explained that in the early years the thinking was that behavioral change can be realized if people are provided with adequate information or that creating awareness would change the way people act (behave). The assumption of this approach was that improvement in knowledge would positively affect attitude and hence behavior. However, this approach did not work and people needed more than just knowledge to take up a new course of action toward desired health/nutrition behavior (Contento et al., 1995). Later, with the understanding that knowledge alone wouldn't be a sufficient factor to bring behavioral change, a shift was made toward the application of behavior-based theories to guide nutrition education interventions (Contento et al., 1995). Therefore, these behaviour-change theories were classified under the new models of nutrition education.

Some of the common behaviour change theories that came about with the new approach include:

Health Belief Model (HBM): emphasizes that healthy behavior is dependent upon individuals' perception of their vulnerability to a health risk or the severity therein, and their perception of effectiveness/benefits of the treatment presented (Hochbamum, 1956; Rosenstock, 2005). It is one of the earliest models of behaviour change. The model has been criticized mainly for focusing only on individual behaviour without regard to other socioeconomic and environmental factors which may encourage, according to the critics, 'victim-blaming' (Raingruber, 2014).

*Theory of Reasoned-Action (TRA) (*later evolved to the *Theory of Planned Behavior, TPB)*: asserts that people's intention to change/take a required course of action is dependent on their attitude toward the behavior, expectation of the outcome of the behaviour (perception of how difficult/easy the behavioral change is), and their belief about how significant others (e.g., their peers, families) would respond to the specific behavior (Ajzen, 1985; Elder, Ayala, & Harris, 1999; Fishbein & Ajzen, 1975). Similar to the HBM, the TRA has initially been criticized for not including environmental factors and for ignoring the fact individuals do not control all behaviors (e.g., cravings); TPB is also criticized for ignoring the role of emotions.

Social Cognitive Theory, SCT (Social Learning Theory, SLT): emphasizes how behavior is determined through the interactions between people and the environment and how one influences the other in a reciprocal manner—the people's ability to interact and learn as a group to shape the environment for collective benefit (Bandura, 1999; McAlister, Perry, & Parcel, 2008). The main concepts in SLT are "reciprocal determinism" (between the person/behavior and environment), “behavioral capabilities” (knowledge/skills needed to do the behavior), “expectations” (of outcome), self-efficacy (one’s ability/confidence to take action), “observational learning” (by following the examples of others) and “reinforcements” (responses to behavior based on the increased/decreased likelihood of reoccurrence) (Raingruber, 2014). It has also been suggested that SLT is the most recognized theory.

Transtheoretical Model, TTM or Stages of Change Model, SCM: states that people’s behavioral/cognitive changes or intentions to change progress from being unaware of/uninterested in, or not considering, the benefits of changes (pre-contemplation) to being aware of/desiring to change (contemplation), then thinking about the change (preparation for action), to doing the action and maintaining it consistently for about 6 months (Elder et al., 1999; Prochaska & DiClemente, 1983). The TTM focuses on interventions at each stage rather than on individuals.

Other models also include *Social Marketing* (applies the principle of marketing to ‘sell’ a desired health behaviour specifically tailored to a particular target group). *The Learner-Centered Approach* is another model that encourages the active participation of the targets in doing the learning for themselves, as opposed to the teacher centered-approach.

Ecological model

Social Ecological Model, *SEM*: originates from *system theory* and aims to apply health promotion interventions at various levels of the system (from intra-personal, to interpersonal, ‘primary groups’, community/organization/institutional and policy levels). The higher the level of intervention in the ecological model, the more people it may benefit (Contento, 2011; Raingruber, 2014).

Apart from the ecological models and Social Cognitive Theory, some behavioral theories that focus mainly on individual behaviors have been criticized for leaving out the environmental, socioeconomic and policy factors (Stokols, 1996). In addition, the concepts and constructs of several of the models and theories overlap, and there is a continued need in nutrition education to develop a more comprehensive theory with each construct independently predicting certain nutrition-related health behavior (Achterberg & Miller, 2004). The next section (Section 2.10.2) provides additional details about one of the earliest models, the Health Belief Model.

2.10.2. The Health Belief Model (HBM)

The HBM, the oldest behaviour change theory, was developed in the 1950s to understand why people fail to participate in preventive or diagnostic health programs that were intended to reduce risk of disease (Champion & Skinner, 2008; Hochbamum, 1956; Rosenstock, 2005).

In the latest edition of her book 'Nutrition Education…' Contento summarized the core concept of the HBM theory in simple terms; i.e., "…peoples' beliefs influence their health-related actions or behaviors" (Contento, 2011). She also described the model as a framework to understand people's psychological readiness or motivation to take a given health related action.

The HBM is composed of a number of concepts that predict why people behave in certain ways or take certain actions to prevent, to screen for or to control health concerns (Champion & Skinner, 2008). These concepts, known as constructs (beliefs) of the HBM, include perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy and cues to action. The six-constructs of the Health Belief Model may be summarized as follows, based on the descriptions of the model in Contento (2011) and Champion (2008):

Perceived susceptibility: refers to people's belief of the possibility or likelihood of contracting a disease or a health problem, for example, a mother's belief about the likelihood of being malnourished if she does not change her current dietary habits.

Perceived severity: refers to the belief or feelings about the seriousness of contracting a disease or a health problem (e.g., being undernourished). It includes evaluation of the consequences of the health problem in terms of pain, mortality or morbidity and other costs.

Perceived benefit: refers to people's beliefs or opinions as to how beneficial taking available courses of actions against the health problem might be, for example, the extent to which people believe the health benefits of fruit and vegetable consumption determines how much or how frequently people consume fruits and vegetables.

Perceived barriers: refers to the potential perceived negative aspect or difficulties of following a recommended course of action or health behaviour. For example, lack of physical and economic access to fruits and vegetables may act as a barrier for the recommended healthy behavior with regard to adequate consumption of these foods.

Cues to action: external or internal events or factors that may trigger people's likelihood of taking action. A person's sickness or a friend's sickness, the availability of new information or the media may trigger action.

Self-efficacy: refers to one's perceived skill or ability to perform or execute the desired course of action. For example, even if mothers accept their susceptibility to being malnourished and are threatened by the serious consequences of being malnourished because they are not eating well, they may not readily take up the habit of eating well if they perceive they lack the skills needed to prepare healthy meals.

Nutrition education interventions can apply the principles of the HBM theory to initiate desired courses of action in nutrition related behaviour among individuals to effect change at the individual and community level. As described earlier, there is no better theory or model that can be prescribed for all circumstances. Applying one or a combination of theories, according to the specific circumstances, is the preferred option while a more comprehensive and robust theory with greater predictive capacity of nutrition behaviors of individuals and groups is developed (Achterberg & Miller, 2004).

2.11. Future directions: using pulses as a food-based approach to combat micronutrient deficiency

The vital roles of pulse crops in Ethiopian diets and agriculture have been described in earlier sections. Some of these roles include pulses' function as sources of alternative protein and healthy energy, as well as the potential of improved varieties of pulses to combat micronutrient deficiencies, particularly in populations with limited access to animal source foods. It has also been discussed earlier that food-based approaches (dietary modification or diversification) to combat micronutrient deficiencies, such as those of iron and zinc, are the recommended or preferred approaches in developing countries (Gibson, 2006). This is partly because direct supplementation and food fortification strategies require more stable infrastructure, without which the sustainability of such programs may be challenged due to the high logistic demands. The agricultural community has also recognized the fact that supplementation and fortification cannot sustainably reduce micronutrient deficiencies in resource poor countries and thus recommends improving the nutritional value of agricultural produce through plant breeding and the introduction of newer varieties that have potential for mitigating micronutrient deficiencies (Haddad, 2000).

Pulses are already common components of the Ethiopian diet. This means they hold potential for improving the nutrition of the Ethiopian population if knowledge and awareness of pulse nutrition is increased, if increased production and utilization is promoted and if distribution to and adoption of better varieties by farmers (such as iron/zinc bio-fortified pulses) are increased. In addition, since the contribution of pulses to alleviating micronutrient deficiency is dependent upon the bioavailability of the nutrients they contain, strengthening improved household-based processing and preparation of pulse foods with reduced levels of anti-nutritional factors (such as phytic acid/phytate which inhibit absorption of divalent metals like iron and zinc) would be equally important to enhance the nutritional impact of such initiatives. A recent study by Getenesh Birhanu and colleagues documented significant reduction in phytate content and improvement in the protein content of maize and haricot bean based complementary food by using simple household-based processing (soaking, germination and roasting) (Getenesh et al., 2014). Another study (Kebebu, Whiting, Dahl, Henry, & Abegaz, 2013) in southern Ethiopia also showed significant improvement in the protein content of a porridge that was prepared by adding a processed broad bean flour to maize flour in various proportions for preferred sensory acceptability. These can be considered a step in the right direction in terms of using pulse-based food products to combat micronutrient deficiency through food-based approaches.

National surveys and other localized studies have documented the existence of high prevalence of micronutrient deficiencies in Ethiopia, including that of iron and zinc. A recent DHS survey reported very high (44%) prevalence of anemia among children between 6 months and 5 years of age. Even though there is no direct measure of zinc deficiency at the national level, the very high (44.4%) prevalence of stunting coupled with the low consumption of animal source foods and the dependence on high phytate-containing staple foods (IZiNCG et al., 2004) indicates the likelihood of the existence of zinc deficiency in the country. Furthermore, the few studies that looked at zinc nutrition in mothers and children reported high prevalence of zinc deficiency in these groups (Abebe et al., 2008; Gebremedhin et al., 2011; Umeta et al., 2003).

Given the potential to improve the nutrition of the Ethiopian population (particularly that of mothers and young children) by linking pulse agriculture with nutrition/ nutrition education, investing in this area may present a valuable opportunity to improve nutrition of the overall population. The current study may also provide valuable input to guide current and future interventions seeking to invest in pulse agriculture and nutrition.

2.12. Summary

Maternal and child undernutrition is a continued global challenge but is declining gradually. However, progress is uneven in certain regions of the world and appears to be even slower in sub-Saharan Africa, to which Ethiopia is a part. Despite the recent pro-nutrition policy environment and a continued modest reduction in the level of chronic child undernutrition (as estimated by the prevalence of stunting in children under 5 years of age), the very high prevalence rates reported in the recent national survey indicate a long journey ahead for the country before lowering down the problem of chronic maternal and child undernutrition to targeted levels. Prevalence rates of maternal undernutrition (a BMI <18.5), a known risk factor for child undernutrition, have also remained consistently high at ~27% for the last three consecutive DHS surveys, also indicating the need to strengthen efforts to tackle maternal undernutrition should the country achieve the goals set to reduce stunting and underweight.

Pulses have been an integral part of the Ethiopian diet for many years. Pulses are higher value crops than cereals and are known to have twice or more the amount of protein than cereal crops. Increased production and consumption of pulses (particularly the ones bio-fortified for increased micronutrients like iron and zinc) can be leveraged to improve nutritional health in mothers, young children and the general populations. However, availability of studies documenting the impact of pulse-agriculture on nutrition of subgroups in Ethiopian agricultural communities, much less those that incorporated nutrition education intervention, are limited.

Hence, the aims of the current study were: to characterize and compare the nutritional health of mothers and children in pulse-growing and mainly cereal-growing (with no or very limited pulse production) rural communities of Ethiopia; and to compare nutritional outcomes of these communities with the most recent national and regional data, regardless of their pulse production status. In addition, community-based nutrition education intervention on promoting pulses as part of healthy meals was piloted in the pulse growing communities, and outcomes were compared to baseline data and a comparison community. Based on feedback from the pilot study, strategies will be sought for scaling up the project in the future.

Chapter 3 General Methodology

3.1. Introduction

This chapter describes the study setting, participants, data collection process and tools used. The research applied mixed methods approach, supplementing quantitative data with qualitative information from focus group discussions (FGD). The quantitative component utilized combination of cross-sectional and quasi-experimental designs to address the different objectives of the study. The cross-sectional studies provided baseline information that was used both for characterizing nutrition and food security situations of the study communities and for baseline comparison of pulse versus cereal communities. These studies also provided baseline data to inform the design and implementation of an intervention study in the pulse community. Study participants were mothers and their young children (<5 years of age) in selected districts in the SNNPR and Oromiya Regions.

Data collected included socio-economic and demographic characteristics of participants, IYCF practices of mothers, dietary and health related behaviour and practices of mothers during pregnancy and lactation; information related to pulses, dietary diversity, food frequency, a single-day weighed food record and anthropometric characteristics of both mothers and their young children were collected. In addition, information on health belief of mothers as well as food security situation of participants' households were also obtained.

Dietary assessment included analysis of selected macro and micronutrient contents of commonly consumed local foods from the study sites.

This chapter begins with description of the study areas. Description of the study design follows with schematic representation of the conceptual framework for the project. Next, a brief description of the study population is provided, followed by statements about ethical approvals to conduct the study. The final sections present sample size determination, data collection procedures, analysis of data and a description of the planned intervention.

3.2. Study areas

This study was conducted in two rural communities of southern Ethiopia (Halaba area) and one rural community from Oromiya region (Zeway area)[5]. The communities were selected

[5] This thesis work was part of a larger collaborative project by Hawassa University and University of Saskatchewan being implemented in these study sites as well as other locations in Ethiopia.

purposively based on whether or not they predominantly grow any of the common pulses (beans, lentil, and peas) grown in Ethiopia. For the purpose of this research, "predominantly grow pulses" meant that majority (at least >50%) of the households in the communities grew some type of pulse-crops regularly each year and that the communities were identified as pulse growers by the local agricultural office. Being a non-pulse or being mainly a cereal-based community meant that majority of households did not grow any pulses on a regular bases and the community was identified as cereal-based by the local agricultural office.

For the purpose of this research, two pulse- and one mainly cereal-growing communities were needed. Since there were more communities that met these criteria, selection in the pulse-growing communities was made with the help of the local agricultural office. Accordingly, two top pulse-growing communities were selected from a list of communities in Halaba district based on their previous history of pulse production record. Likewise, the third predominantly cereal-based community was again selected with help of the respective agricultural office from Zeway area. Since a mainly cereal-based ("non-pulse-growing") community was needed for baseline comparison with pulse communities from Halaba, a similar process was followed to identify a mainly cereal-based community that was not known for regular pulse production.

As mentioned above, the two pulse growing communities were selected from Halaba Woreda/District, in Southern Ethiopia. Halaba District is located 315 km south of Addis Ababa, the nation's capital, and about 85 km from Hawassa, the capital of SNNPR, Ethiopia. Geographically, the area is located 7°17' N latitude and 38°06' E longitude. The District shares borders with Oromiya region in the west, Hadiya in the north and Kembata Tembaro in the east. Halaba is one of the eight special Districts in SNNPR (i.e., the administration directly reports to the regional government instead of Zone offices). The District is subdivided into 79 rural and two urban Kebeles (smallest administrative units in government structure, referred as communities in this document). Based on the 2007 Census, the District's population was over 271,000 of which women constituted 49.5% (CSA, 2007). Most of the population (89%) reside in the rural parts of the District. Halaba followed by Gurage are the two ethnic groups in the area comprising 81% and 10% of the total population, respectively.

The agro climatic condition is suitable for growing diverse cereal crops, pulses and root crops. From pulse crops, haricot bean was the most common pulse grown in the area, based on a 2005 report. Other pulses include faba bean and lentils. The area also has a good potential for production of soya beans and other vegetables and tropical fruits (such as avocado, papaya and mango). Maize, teff, wheat, pepper and haricot bean are dominant crops in terms of crop area coverage. Two of the crops selected as priority marketable commodities by farmers and experts and covered by specialization extension program are pepper and haricot bean. The soil of the area is generally fertile and farmers may harvest good yield even without application of artificial fertilizers, provided there is a good rain pattern.

Although Halaba farmers commonly grew haricot beans from pulses, the area has been known to hold the potential for other pulses crops such as chickpea and lentils which have higher market values. Based on this realization, CIFSRF[6] supported an Ethio-Canada collaborative research project between Hawassa University and the University of Saskatchewan has introduced chickpea and lentil production since 2008 and has since been improving productivity of these crops through various farm management practices (IDRC, 2014). Hence, it was fitting to evaluate whether the practice of pulse agriculture translated to nutritional health benefits in the rural communities of Halaba.

The third community was selected from Zeway area, specifically from *Adami Tulu Jido Kombolcha* (ATJK) District. The District is located just south of Zeway town, the capital for the District. Administratively, the ATJK is part of East Shoa Zone, under Regional State of Oromiya. It is also about 160 km South East of Addis Ababa, the capital of Ethiopia. The Woreda also lies between 7˚35”–8˚05” N and 38˚20”-38˚55” E in the northern part of the great east African Rift Valley and with altitude range of 1500-2300m above sea level. It shares border with Dugda Bora Woreda in the North, SNNPR in the west, Arsi Negelle Woreda in the south and Arsi Zone in the east. Plain and flat lands of volcanic origin with small mountains, hills and gorges extending from northern part of Central Rift Valley are characteristic features of the Woreda. It receives an average annual rainfall of 760mm with mean monthly temperature ranging from 18.5˚C to 21.6˚C.

The Woreda has an estimated population of 189, 202.00. It hosts a total of 47 Kebeles (42 rural and 4 urban Kebeles) and equivalent number of Health Posts with around 91 Health Extension workers and 76 primary schools. Islam is the principal religion in the Woreda.

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[6] Canadian International Food Security Research Fund

The Adami Tullu Jido Kombolcha district is divided by the main asphalt road connecting Hawassa town to Addis Ababa. The district is relatively better positioned to research centers such as Adami Tullu Agricultural Research and Melkassa Agricultural Research Centers, which creates a good opportunity for accessing research based knowledge, better/newer varieties and crop management practices. Adame Tullu Jido Kombolcha (ATJK) was selected to represent the third community which was cereal-based. Maize, teff, wheat, barley and different oil seeds are the major agricultural crops produced in the District. This has enabled us to compare maternal and child dietary practices and nutritional status with communities from Halaba where pulses crops were commonly grown. Adami Tullu Jido Kombolcha also represents a dry land, irrigated and rain-fed agriculture [Source: Regional Health Bureau and (Regassa & Tsegaye, 2013)].

3.3. Study design

As noted earlier, a cross-sectional and a between group quasi-experimental research designs were applied for this project. The cross-sectional design allowed for calculating single population proportion (such as stunting in under-five years of age children and undernutrition in mothers) (Chadha, 2006). This design was employed to answer the first two objectives of the thesis (i.e., those concerned with characterizing the gender, food security and nutrition situations as well as baseline comparison of pulse versus cereal communities) which, in turn, provided baseline data for the intervention study.

Along with the cross-sectional design, a quasi-experimental intervention study was conducted to pilot and assess the effect of a pulse nutrition education intervention (described later).

Between group intervention designs consider two similar communities/groups where one receives the intervention while the other, not receiving the intervention, serves as a control (Gibson, 2005b; Habicht, Victora, & Vaughan, 1999). Unlike within group designs, between group designs allow comparison of outcomes between groups/communities, providing more plausible evaluation of outcomes. The intervention in this study was quasi-experimental in design as participants in either community were not randomly assigned to be in the intervention or comparison community. Instead, participants in the community with worse baseline nutritional status (i.e., higher child stunting and maternal undernutrition) were assigned to receive the intervention while participants in the second similar community served as a comparison community. Accordingly, the two pulse-growing communities (one receiving and the other not receiving the intervention) were used for piloting the intervention. Figure 3.1 illustrates the schematic representation of the intervention design. Note that the second community not receiving the intervention were referred as "comparison community" as opposed to "control" since the two communities, despite a number of similar characteristics, were slightly different in the main outcome variables (levels of stunting and undernutrition in mothers).

The qualitative component of the research design was FGD conducted at baseline with the local farmers who were husbands of the participating women in each of the three communities. The FGD was repeated for the intervention communities at the end of the intervention. The purpose was to understand the farmers' perceptions, knowledge, attitudes and practices regarding pulse agriculture and pulse nutrition. The information generated from the FGD helped in the design and implementation of the intervention study. The FGD itself also provided a platform for discussion and exchange of feedbacks following the intervention.

3.4. Study population and selection procedure

The study population were mothers and their under-five years of age children from households residing in three rural communities of Halaba and Zeway. The inclusion criteria were households having at least one under five years of age child and a mother, in addition to being residents of the selected community. All mothers, along with their young children, who consented to participate in the study and who met the inclusion criteria were recruited for the study. The interview questions had items that asked for any recent sickness (in the two weeks prior to the interview) in the mother and/or the child so that appropriate measure could be taken during data analysis to control for bias on some of the nutritional outcome measures, such as wasting and underweight in children or the mothers.

Participants for the FGD were local male farmers from each of the three communities and were selected based on recommendation from local people for their knowledge of the local community and its farming practices, having lived in the communities for several years.

Multiple steps were followed to select the participants. Frist the three communities were selected purposively based on the criteria for growing or not growing pulses. For the purpose of this study, a community was considered pulse-growing if the farmers grew any pulse crops (beans, lentil or pea or any variety of these) as a common practice along with other crops.

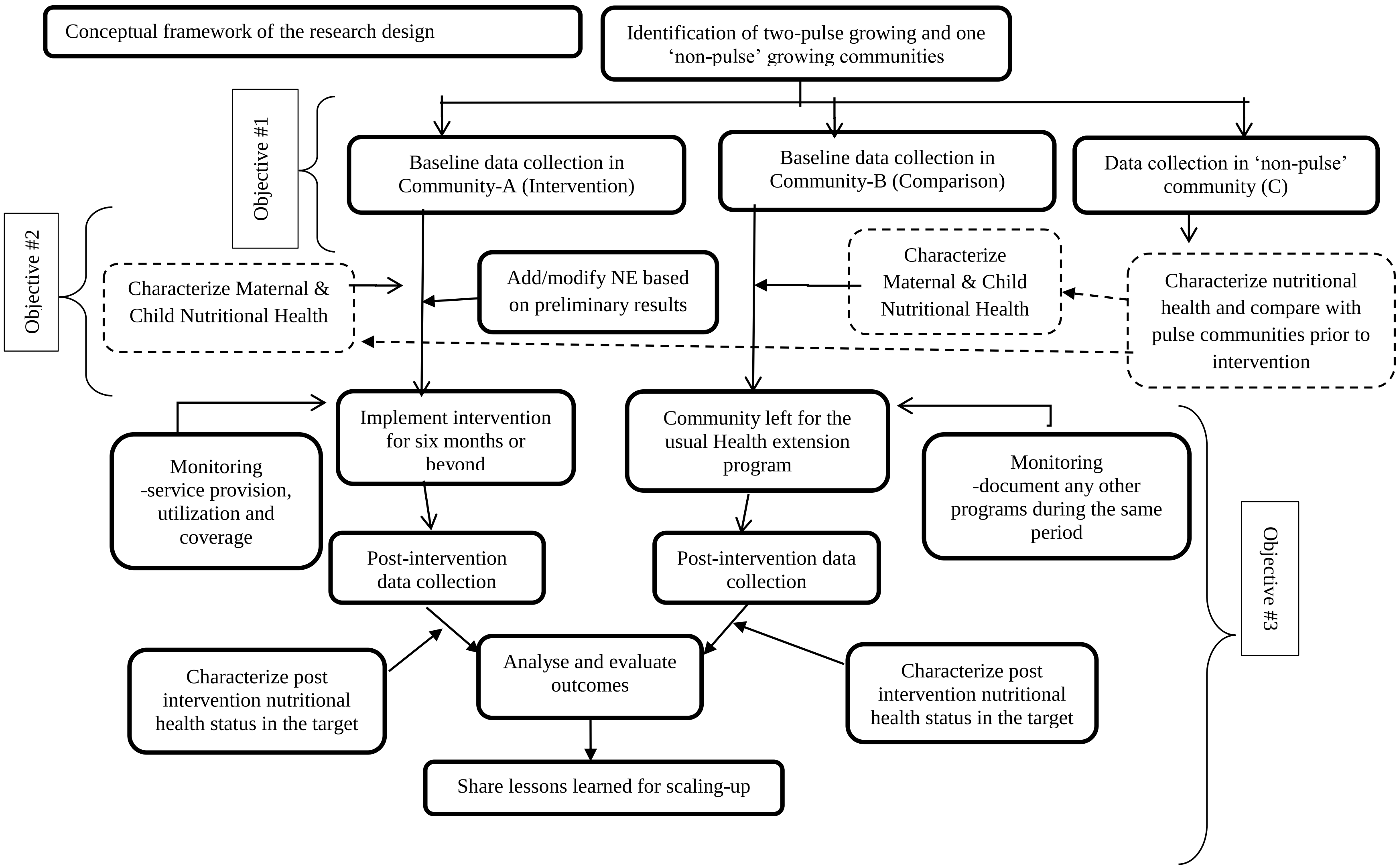

Figure 3.1 Conceptual framework of the research design

Then, eligible households for the study (the ones that are occupied by mothers and under five years of age children) were identified with the help of local Health Extension Workers' registry, list of households served by a local Health Post, in each of the selected communities. Where registry was not available, the list of households with eligible participants was developed by house-to-house registry with help of local health promoters and health extension workers. Age of child was determined from immunization cards and local calendar events. Both breastfed and non-breastfed children less than five years of age were considered. In households where there were more than one <5y of age children, the youngest was considered for the study.

3.5. Sample size determination

The first part of the research aimed to characterize nutritional health status of the participants in the study area. Findings were compared with recent national and regional reports, as well as other similar studies in other communities. This required representative sample size from each community. Therefore, the following formula was used to calculate a representative sample size in a cross-sectional community-based survey design (Chadha, 2006; Fisher, Laing, Stoeckel, & Townsend, 1998):

$$\boxed{n_o = [(Z_{1-\alpha/2})^2\ P\ (1-p)]/\ d^2} \text{ and } n = n_{\circ}N/[n_{\circ} + (N-1)]$$

where n_o & n= estimated sample size without and with consideration of 'finite population correction factor, N= total population (under five years of age children in the area), Z = 1.96 = standard normal variable at 95% confidence interval, P= expected prevalence of the problem in the population (maternal undernutrition/child stunting in this case), and d = desired degree of accuracy or margin of error. Since the study focused on maternal nutritional health and their young children, the recently reported 27% rate of maternal undernutrition was taken as expected prevalence of the problem (P) (CSA & ICF International, 2012). To allow higher degree of precision, the margin of error (d) was set at 5%. The final sample size was corrected after a sampling frame had been built and 'finite population correction factor had been applied. Accordingly, the sample size for one rural community was ~200 mother-child dyads. The total sample size for the three communities was about 600. With 5% contingency to account for dropouts, the final sample size was set at 630 mother-child pairs.

For the qualitative component (i.e., for FGD), about 10 experienced male farmers in each of the three communities (a total of 30 farmers) were recruited. The FGD were conducted separately in each of the three communities and were repeated in the two communities in the intervention design following the six-month intervention.

3.6. Tools, data collection procedure and data collectors

Data collection tools included the following: a structured questionnaire, weighed food record and anthropometric measurement forms and equipment as well as discussion questions for FGD. The structured questionnaire contained questions regarding socio-economic and demographic status as well as sections on food security, dietary diversity, food frequency and child feeding practices. The questionnaire also had a component with questions on pulse agriculture, awareness of the nutritional importance of pulses and utilization of pulses. The contents of the questionnaire (i.e., interview questions on socio-economic and demographic characteristics and questions on diet related practices) were adapted from previous studies in similar settings (EHNRI, 2010; Ersino et al., 2013; Tessema et al., 2013). Weighed food record and anthropometric forms were also used. Forms for the weighed food record and body measurements as well as the guideline to conduct them were also adapted from previous studies as outlined in Gibson's text book (Gibson, 2005b). Details and purpose of each tool is described below.

3.6.1. Questionnaire

A semi-structured interviewer administered questionnaire was used to collect data from participants. The questionnaire contained both open-ended and closed-ended questions, and was administered by a trained research assistant. The use of interviewer to administer the survey was preferred because of the low literacy rates in rural Ethiopia (EHNRI, 2010). Most surveys, including EDHS, are conducted through an interviewer. There are eight sections to the questionnaire used and each section has been described below.

Section I. Socio-economic and demographic profile of participants**:**

This section included information on household size, age, sex, household facilities, major income sources, religion, education, farmland ownership and animal ownership. Such information was used to characterize the nutritional health of mothers and children in the context of these background information of the participants.

Section II. Maternal health and nutrition:

This component asked for general dietary habits of mothers during pregnancy, lactation and for existence of food taboos. A few items asked for maternal knowledge regarding good nutrition, iron rich food sources, current health conditions and physiological status and health seeking behaviors.

Section III. Youngest child nutrition (child feeding practices):

This section of the questionnaire asked questions about breastfeeding and complementary feeding practices of mothers for children <24 months at the time of data collection. Variables such as initiation of breastfeeding, the giving of colostrum & pre-lacteal feed, exclusive breastfeeding, timely initiation of complementary feeding, quality of complementary foods and frequency of feeding were included to assess whether child feeding practices in the study communities adhered to WHO feeding recommendations. Mothers were also asked if the child had suffered any sickness in the two weeks prior to data collection days. Child sickness status was used to control factors, other than diet, that might have affected the child's anthropometric indicators of nutritional status.

Section IV. Questions related to pulses production and consumption, and questions on constructs of Health Belief Model:

Items in this section included questions that assessed which pulses households grew, how often and in what capacity (size of production) they grew them. Questions asking the purpose of the production of pulses (market or household consumption or both), who eats them and who controls the production (men or women, or both) were also included. Other questions in this section assessed the attitude of participants toward pulse consumption, their knowledge of nutritional benefits of pulses compared to other cereal staples and the challenges they faced with regard to production and consumption of pulses. These questions and others were used to draw associations between nutritional health outcomes and the practice of pulse agriculture.

In addition to the general questions on pulses, three items for each of the six constructs of the Health Belief Model (HBM) were included with a five-point Likert Scale. The questions were mainly framed around HBM constructs (i.e., perceived susceptibility and severity, perceived benefits and barriers, self-efficacy and cues to action) in the context of production and utilization of pulse crops. The questions were intended to measure, for example, the mothers' perception of their own and their children's susceptibility to undernutrition due to poor dietary practices. For example, mothers were asked to what extent they agreed or disagreed to a statement intended to measure their *perceived susceptibility* to undernutrition: *"If I eat less than usual during pregnancy and lactation, I may become malnourished"*. The following was an example of item used to measure mothers' *perceptions of severity* (of undernutrition): *"If my child is malnourished at early years (0-5y), it does not bother me a lot because he/she will be well when grown up"*. In a similar fashion, questions were added to measure mothers' *perception of benefits* of pulses or pulse production and barriers to consumptions. Items to measure mothers' *perceptions of cues to action* (such as producing pulses at household level, willingness to purchase for home consumption and existence of nutrition education services promoting pulse nutrition) were also included. The last three items in this section also assessed mother's perception of their *self-efficacy* to adopt healthier dietary practices including preparation of pulse-based meals for the family.

Sections V-VI. Household food security (introductory and main items):

To examine household food security status and the contextual factors associated with it, a household food security questionnaire developed by the USAID Food and Nutrition Technical Assistance (FANTA) (Coates et al., 2007). The questionnaire is called Household Food Insecurity Access Scale (HFIAS) Version 3. It contained nine items which were later calculated to categorize households at different levels of food security and household hunger. This method has been suggested for use in developing countries by FANTA and, also allow comparison of outcomes with previous studies that have used this method to assess levels of household food insecurity. In addition, FANTA has developed a Household Hunger Scale (HHS), a tool to assess presence and degree of household hunger, using the last three of the nine items on the HFIAS (Deitchler, Ballard, Swindale, & Coates, 2011). This tool was also used to assess household hunger in the study communities here.

Section VII. Food frequency questionnaire:

In section VII, the food frequency questionnaire was designed to collect data on the frequency of consumptions of common pulses, any meat, poultry, fish, any fruits and vegetables. This was used to analyze how often pulse or animal source foods were available for consumption to the mother and child, and to determine the role of pulse in augmenting protein and other micronutrient supplies in the diet.

Section VIII. Diet diversity questionnaire, a 24 h recall over the day and night preceding the interview day:

To obtain a proxy to quality of diet consumed by mothers and children in the communities, a dietary diversity questionnaire was included in this section to obtain data for the mother and participating child. The dietary diversity assessment method was adapted from an FAO guideline for measuring individual and household dietary diversity (Kennedy, Ballard, & Dop, 2011). This tool was designed to help answer questions such as "does the dietary diversity score of mothers and children in a pulse-growing community differ from those in a non-pulse-growing community?". Mothers or caregivers were asked to recall all food items consumed on the days and night proceeding the interview day. Mothers were asked to describe any food (main meals and snacks) that they consumed both at home or outside of home, starting from the first food consumed. When finished, mothers were probed to remember any meal or snack not mentioned. Once the mother finished recalling her own food intake, she was asked to recall foods given to/consumed by the child over the same recall period as the mother. Mothers were probed for foods and drinks given to the child during the day or night but not mentioned.

The dietary diversity questionnaire had a table for interviewers to list all meals and snacks consumed by participants at different times of the day or night. Then, interviewers (checked by the principal investigator) filled out another table containing list of all food groups using the previous table that contained list of all food items recalled by participants. The list of foods given in the food group table were adapted to reflect local foods (that means, example of foods listed under each food group were local foods). The interviewer gave a score of "1" if the participant consumed any from a specific food group or a score of "0" if the participant did not consume from a specific food group given in the questionnaire.

3.6.2. Weighed food record

In addition to the interview questionnaire, a one-day weighed food record data were collected in a subsample (a total of 209 mothers and 209 children) of the study participants using food weighing scales (2 kg maximum weight: Model CS 2000, Ohaus Corporation, Parsippany, NJ, USA). Due to the demanding nature of collecting weighed food record data in rural setting, only 70 mother-child pairs (35% of the total sample) from each of the three communities participated in the one day-weighed food record data collection. Selection of participants was random and the criteria were being part of the ongoing study and having a breastfeeding child >6 months of age. The data collectors arrived at the participants of home early morning before breakfast and stayed with the mother-child until the last meal for the day in the evening (see more details in chapters 5 and 7). The weighed food records were used to calculate mean intakes of energy, protein and selected micronutrients such as iron, zinc and calcium. A single-day weighed food record collected from representative sample of a population, and on week days and weekends, can be used to estimate average dietary intakes of groups (Gibson, 2005a).

In this study, median dietary intakes of energy, protein, zinc, iron and calcium by mothers and children in pulse growing community were compared to participants in 'non-pulse' growing community and the result helped to inform if there was any benefit coming from production/consumption of pulses that translated to nutritional health of participants in the respective communities. Therefore, a separate form was prepared to collect a weighed food amount consumed by participants for one day during the study period. The form also contained a recipe page for recoding ingredients in cases of mixed-dishes. However, no mixed dish was identified during the data collection (see details in chapter 5 and 7).

3.6.3. Anthropometric measurement form and measuring equipment

As an indicator of both chronic and acute nutritional health status among mothers and children, various body measurements were taken by the PI. Anthropometric measurements of body size are widely used nutritional assessment methods reflecting past, present and even future nutritional health situations at both individual and population levels (Gibson, 2005b; WHO Expert Committee on Physical Status, 1995).

The measurements included: Mid-upper-arm-circumference (MUAC) of mothers and their <5 years old children, head circumference and triceps skinfold thickness of children, height/recumbent length and weight of mother-child dyads. The anthropometric measurements required the following equipment: height and recumbent length measuring board (Shorr measuring board, Shorry production, LLC US); infant, child and adult weighing scale (UNICIF scale Seca); head circumference measuring tape; MUAC measuring tape; caliper for measuring triceps skinfold thickness;

3.6.4. Focus group interview guide

An interview guide was prepared to collect qualitative information from experienced farmers in each of the study communities. The interview guide contained seven main questions that enquired farmers to share their insight on topics such as commonly grown crops in their communities (including pulses), challenges of pulse production, farmers' knowledge of benefits of pulses, attitudes toward pulse-based foods as well as farmers' intention to produce more pulse crops (see last section of Appendix E). The discussion was voice recorded and transcribed by the student researcher. The purpose of integrating the FGD as part of the data collection tool was to obtain views of experienced local farmers on perceived benefits and challenges of production and consumption of food crops, particularly pulses, in the study areas. Also the FGD provided feedback on the effect of the six-month nutrition education in the intervention community (some key insights/opinions of the farmers from the intervention community has been shared in chapter 8, study 5).

3.6.5. Data collection, data collectors and quality control

Data collectors who were able to speak the local language were trained on how to administer the questionnaires and conduct weighed food record in each of the three communities. The training focused on understanding each component and item on the questionnaire. Training was carried by the principal investigator and trainees were given a copy of the questionnaire and forms to go through each item during the training sessions. Trainees also had a chance to exercise the questionnaire with other partners. Likewise, the training on the weighed food data collection focused on familiarizing data collectors with the forms and the ability to operate food weighing scales. Local food samples and weighing scales were provided to practice on how to correctly weigh and record the measurement on the appropriate space on the weighed food record forms. The trainees were given ample information on how to take recipe data for mixed dishes (dishes from different ingredients).

The training session lasted 2-3 days at each community. The research team as a whole were notified on the importance of respecting the local culture and behaving in a manner acceptable by the culture. Efforts were made to recruit local data collectors with some post-secondary school training (mostly nurses) who understood some English. This has helped to facilitate the training sessions as some not-so-easy-to-translate terms and concepts were explained both in English and the local language. The local language translation of each question was placed in parenthesis next to each respective item. This was another help for data collectors to understand concepts, not easily understood in the local language, by comparing them to the English equivalent.

The body measurements were done by the principal investigator (PI) to minimize the bias that might be introduced by measurers. Measurements were taken twice; a third measurement was added when difference in the first two exceeded acceptable range (Frisancho, 1990; Gibson, 2005b). This was achieved, for example, by measuring the height of a child to the nearest 0.1cm and repeating the same measurement for a second or a third time until the difference in the closest of two measurements was within 0.5cm. Similar procedures were applied for the other anthropometric measurements. The PI also carried out the FGD in each of the three study sites separately at baseline which was repeated in the intervention and comparison communities at endline. A voice recorder was used for the FGD which helped the facilitator to maintaining eye contact and engagement. The weighed food record and the interview were carried out at the residences of the participants by trained female data collectors. Anthropometric measurements were done at local Health Post or Health Center.

Research assistants and the PI supervised for data quality at the field level and missing or incorrect data were corrected at the field level. Furthermore, all continuous variables were checked for outliers by using scatterplots and frequency distributions and suspicious values were checked and corrected with the help of local research assistants.

3.7. Data analysis

All data from different components of the questionnaire were entered to an SPSS computer program by research assistants/ researcher and were further cleaned. Analysis included, but not limited to, the following:

- Descriptive statistics: to present demographic, socio-economic profiles of participants as well as various feeding practices of infants and young children, household food security and hunger situations and for prevalence estimates of maternal undernutrition and child stunting;
- Dependent and independent sample *t*-tests (or the non-parametric equivalents, i.e., Mann Whitney *U* and Wilcoxon's tests): to compare significance difference in median dietary intake and anthropometric nutritional status within groups and between groups;
- Chi-square and McNemar tests: to compare data for categorical variables at baseline as well as in intervention design;
- Regression analysis (logistic regression and multiple classification analysis): to explore factors that may have significant influence on maternal and child nutritional health status as well as on household food insecurity or hunger in the study communities;

Weighed food record: Dietary intake data from the single day weighed food records were evaluated by first preparing a local food composition table on a Microsoft excel spreadsheet. Nutrition information from Ethiopian Food Composition Tables (EHNRI, 1998a, 1998b) and other similar data bases, such as the USDA (USDA Agricultural Research Service, 2014) were used. The constructed local food composition table included all food items consumed in the study communities with their respective energy and nutrient values per 100g of edible portion. For those food items whose nutrition information could not be obtained from existing food composition tables, samples of those foods ('as eaten') were collected and analyzed (particularly for moisture, protein, zinc, iron and calcium) using approved AACC international methods (more details is provided in section 5.2.2). Using these analyzed nutrient values and those from existing food composition tables, the local food composition table was completed and used as a reference to calculate actual dietary intakes of mother-child dyads from the 1-day weighed food records. This was accomplished by listing all foods and drinks consumed by each participant in separate table on the same spreadsheet as the local food composition table along with the actual weight of food consumed. Next, the foods consumed (in grams) were converted to nutrients equivalents using the food composition prepared earlier. Then, the sum of nutrient values (e.g. protein) from all food items consumed by the participant were transferred to SPSS spreadsheet and median dietary intakes for the different nutrients were calculated. Median intakes were compared between/within groups were also expressed as percentage of the Recommended Nutrient Intake (RNI), where this was possible. More details regarding weighed food data collection and analysis can be found in *Section 5.2.2.*

Anthropometric data: Maternal undernutrition status was determined based on the WHO classification of body-mass-index of less than 18.5 kg/m^2. Mid-upper-arm-circumference (MUAC) measurements were analyzed for pregnant women instead of BMI since MUAC is relatively stable during the period of gestation unlike BMI (Gibson, 2005b). Data on child anthropometry was analysed with reference to the new WHO 2006 growth standard and the new *WHO Anthro (Ver. 3.2.2) 2011* software was used to enter and analyse the data.

Software used: SPSS (SPSS Statistics Version 20, IBM Corp., Armonk, NY, USA), WHO Anthro 2011 (ver. 3.2.2, World Health Organization, Geneva), and Refworks and Endnote X7.5 (Thompson Reuters, 1988-2016) reference managers.

Qualitative data analysis: Qualitative information obtained from open-ended items from the questionnaires were summarized and coded. Qualitative information from the Focus Group Discussions (FGD) with farmers were first transcribed into their equivalent in English by the student researcher (GE) who also conducted the FGDs. Then the farmers' thoughts/insights were summarized in themes following the main questions on the interview guide. Findings supplemented those obtained through the quantitative assessment.

3.8. Intervention: Community-based nutrition education on promotion of pulses as part of healthy meals in pulse growing rural communities (south Ethiopia)

The nutrition intervention was developed based on preliminary baseline findings and previous studies in the study sites (also other similar settings) that recommended the need for integrating nutrition education in the existing food security programs. While the intervention was specifically designed to promote the production and consumption of pulse crops by emphasising the nutritional and other benefits of pulses, it also addressed the importance of knowledge of food groups, diversifying diet, consumption of fruits and vegetables, sanitation and hygiene and basics tips on nutrition during pregnancy, lactation and early childhood. Upon completion of the initial data collection, a preliminary analysis of baseline data was used to inform the key messages and delivery strategies of the intervention. Detail description of the intervention objectives, components, target population, approach and content of the nutrition education along with a program logic model has been enclosed as Appendix A.

3.9. Ethical clearance and considerations

Ethical approval and permission to conduct the study were obtained from the University of Saskatchewan Behavioural Ethics Board (BEH #12-357), Canada and from the respective Regional Health Bureaus of Oromiya and SNNPR, Ethiopia. In addition, permissions were obtained from local health offices and participating mothers before the study was conducted.

Participants were given adequate information on the purpose and benefit or harm that involving in the research might bring. Participants were assured of confidentiality with regard to the information they would provide and also their full right to choose not to participate or withdraw from the research without any consequence pertinent to their decision in this regard. Each participant was asked to provide oral consent. This was indicated on the consent form that explains the purpose of the research and the research protocol.

Transition paragraph for result chapters

The subsequent chapters (chapter 4-8) present the results of the various studies conducted in this thesis work. Chapters 4-6 present the baseline studies conducted to characterize the maternal child undernutrition in the context of socioeconomic-demographic factors including gender (chapter 4, study 1); child feeding practices and undernutrition in infants and young children (Chapter 5, study 2); and household food insecurity and hunger situations (Chapter 6, study 3). Next, Chapter 7 (study 4) deals with baseline comparison of dietary practices and nutritional status of mothers and children in pulse versus cereal growing communities. The last study (Chapter 8), presents the pulse intervention study conducted in the two pulse growing communities of Halaba. The closing chapter (Chapter 9), presents overall discussions, strength and limitations as well as recommendations for future research.

Chapter 4 Gender, household structure, cultural norms and access to and utilization of health services associate with maternal undernutrition and child stunting in a sample of rural communities in Ethiopia (Study 1)

Abstract

Addressing maternal and child undernutrition is one of the strategic objectives and a priority area agenda for the National Nutrition Program of Ethiopia. The burden of maternal and child undernutrition in two rural communities (Halaba & Zeway) of Ethiopia was estimated and outcomes were compared with regional/national reports as well as explored their associations with gender and socioeconomic-demographic factors (household structure) as well as access-utilization of health services. In a cross-sectional study between March and June 2013, interviewer administered questionnaire was used to collect data from mothers in addition to various anthropometric measurements from both mothers and their <5y of age children in rural communities of Halaba, south Ethiopia, and Zeway, Oromiya region (n=630 mother-child pairs, total). Findings showed that maternal undernutrition (% BMI<18.5) ranged from moderate (14%, Zeway) to high (22%, Halaba). Alarming levels of stunting and underweight [(54% stunting, 36% underweight, in Halaba) and (42% stunting, 21% underweight, in Zeway)] were also found among children. Up to 95% of Halaba and 85% of Zeway mothers reported consumption patterns that were 'same as usual' or 'less than usual' during their most recent pregnancy compared to times of non-pregnancy/lactation. Up to 61% also reported abstaining from consumption of certain nutritious foods for cultural reasons. Factors such as gender and socio-economic-demographic structure of the household, including imbalance of power, physiological density, household size and dietary habits during pregnancy showed significant associations with maternal and child undernutrition ($p < 0.05$), warranting further investigation. The observed levels of child and maternal undernutrition, particularly in Halaba areas were unexpected and of serious concern, given that a national nutrition program administered by the government has been in place for some time. This baseline study provides insights to policy and decision makers to revise and/or strengthen the nutrition programs designed to target vulnerable segments of the population in these regions.

Keywords: Maternal and child undernutrition; gender, social determinants of health, stunting, National Nutrition Program, Ethiopia

4.1. Introduction

Despite progress in the past 15 years, levels of child stunting and maternal undernutrition in Ethiopia remain unacceptably high (CSA & ICF International, 2012). The levels reported in the 2011 Demographic and Health Survey (DHS) showed slight improvement (in children only) compared with previous DHS (CSA and ORC Marco, 2006), but were still *'very high'* by World Health Organization (WHO) standard (WHO Expert Committee on Physical Status, 1995). A mini-DHS survey in 2014 reported a 40.4% prevalence of child stunting in Ethiopia, a small improvement over a five year period (CSA, 2014). Maternal undernutrition, however, had not changed since the first DHS in 2000 (CSA & ICF International, 2012; CSA and ORC Macro, 2001; CSA and ORC Marco, 2006).

Since 2008, the government of Ethiopia has implemented a National Nutrition Program (NNP) that strategically aimed at improving the nutrition of women and children (Ethiopia Federal MoH, 2008b). The NNP set a specific target for reducing undernutrition in children but not for women. For this and other concerns, the NNP was revised few years into its implementation to reflect a lifecycle approach in improving nutrition of women and children, and re-launched in June 2013 (FDRE, 2013). The revised NNP had specific targets of reducing child stunting (from 44.4% to 30%) and undernutrition in women of reproductive age (from 27% to 19%) nationally by 2015. The programme sought to achieve these objectives through strengthening nutrition service delivery within the health sector and nutrition sensitive interventions across sectors. Results of the Mini-DHS survey in 2014, however, indicated the targets (at least for child stunting) might have not been met.

Individual factors such as genetics, behaviour or life-style choices and vulnerability to health issues are not the only determinants of health (Commission on Social Determinants of Health, 2008). One's social status (e.g. gender), housing conditions, education, income, access to services, age and sanitation—collectively known as *social determinants of health*—are factors that need to be considered (Commission on Social Determinants of Health, 2008). Nutrition, a vital component of health, affects and is affected by these factors. Women and young children are among the most at risk for poor nutrition in Ethiopia where disparities across these social and physical environments tend to be greater. Even when food is available, women tend to be malnourished because of their gender status (FAO, 2012). Beyond their biological roles of bearing-rearing children, women usually shoulder other productive and social responsibilities, also known as the *triple roles of gender* (Moser, 1989). These roles clearly add significant work-load on women and increase their risk for poor nutritional status. Undernutrition in women is known to increase the risk of poor nutritional status in children (Black et al., 2008; Kramer, 1987b).

The National Nutrition Program in Ethiopia focuses on improving nutrition for women and children through nutrition specific and sensitive activities, such as food security, diet diversification, therapeutic feedings, supplementation and fortification. The non-dietary factors (such as gender and socioeconomic-demographic factors, and their importance as underlying causes of maternal and child undernutrition) are not emphasized in the program.

The purpose of the study was (i) to estimate levels of maternal and child undernutrition in selected rural communities of Ethiopia and (ii) to explore their association with gender, socioeconomic-demographic factors, access-utilization of health services and nutrition related knowledge/practices of mothers during pregnancy and lactation. The study communities were part of a larger Ethiopia-Canada project between Hawassa University (Ethiopia) and the University of Saskatchewan (Canada) that sought to improve agricultural productivity and human nutrition in south Ethiopia.

4.2. Methods

4.2.1. Study setting, sample and design

The baseline data and reported herein was collected as part of a community-based intervention study in three purposively selected rural *Kebeles*[7] (communities). Two of the communities (*Guba-Sherero* and *Holagoba-Kukie)* were selected from rural *Halaba*, one of the Woredas (~districts) in Southern Nations, Nationalities and People's Region (SNNPR). It is located ~85 kilometers northwest of *Hawassa*, the capital of SNNPR. The district is known for growing pepper and pulses, both considered cash crops for the farmers. The third rural community (*Edo-Qontola*) was selected from *Adami-Tulu-Jido-Kombolcha* (ATJK) district near Zeway town, in the Regional State of Oromiya. It is located about 160 kilometers southeast of Addis Ababa, Ethiopia's capital. Maize, teff, wheat, barley and different oil seeds are the major

[7]*Kebeles* (referred as communities herein) are the smallest administrative units in the government structure and may contain about 500 households each.

crops produced in the district. The area is characterized as dry land with crop production being both irrigated and rain-fed.

In all the three communities, mothers and their children <5y of age were populations of interest. Hence, the inclusion criteria were households in the community that have mothers with at least one <5y of age child. The sample size was determined using formula for cross-sectional studies (Charan & Biswas, 2013). About 200 households with mother child-pairs were randomly selected in each of the three communities. Whenever households had more than one eligible child, the youngest was considered. A total sample of 630 mother-child pairs (413 from the two communities in Halaba and 217 from the third community in Zeway) were recruited. The study was approved by the University of Saskatchewan Behavioral Ethics Board (BEH #12-357) as well as by the Regional Health Bureaus of SNNPR and Oromiya. All mothers gave oral consent to participate in the study. The study was carried out in March-June 2013.

4.2.2. Data collection, tools and analysis

Information on the characteristics of participating households were collected by a questionnaire adapted from previous national and local survey studies in the region (EHNRI, 2010; Roba et al., 2015; Tessema et al., 2013). The data included information on household size (number of usual members of the household), number of children <5y of age, marital status, polygamy, education of mothers and their husbands, household headship, usual occupation, ownership of domestic animals, cultivable land, ownership of various household assets, housing characteristics (roof, floor, window material, number of rooms), sanitation facility, access to drinking water, persons responsible for fetching water and time required to fetch water, women's access to their own farmland, person in charge of agricultural produce and some other variables.

The questionnaire also contained a section that assessed access and utilization of health/nutrition services as well as dietary habits of mothers during their most recent pregnancy and lactation; the items were adapted from nutrition baseline survey for national nutrition program (EHNRI, 2010). Information on access and utilization of health/nutrition services included whether mothers had visited any healthcare facility, type of healthcare facility visited, number of visits, place of delivery of the youngest child, and whether mothers had received iron/folate supplement, as well as whether mothers had received any health/nutrition education during/after their most recent pregnancy. Additional information in this section included whether mothers abstained from eating certain foods during pregnancy for cultural reasons (food taboos), what their eating pattern was like (same, less, more than usual) during pregnancy and lactation, as well as whether mothers knew what balanced diet was.

From the data collected, a set of proxy variables were created to reflect gender, economic and demographic structures of the study households. Difference in years of formal schooling between husband and wife (i.e., years of formal schooling of husband minus that of wife) was used as a proxy measure for empowerment index for the household. The length of time required to fetch drinking water was used as a proxy measure to estimate work burden on women. WHO/UNICEF recommend that drinking water should be accessible within 30 minutes of round trip from the residence (WHO & UNICEF, 2010); thus, if time required to fetch water took 30 minutes or longer this would significantly increase work burden.

Women's access to their own piece of farmland, control over agricultural produce, and polygamy were also variables used to reflect the gender dimensions of participating households. Likewise, information on cultivable land size per household and number of persons per household were used to calculate physiological density (i.e., the number of persons in the household/unit of cultivable land). Physiological density provides information on how much land is available to produce food for the family. Then participating households were placed into two categories (≤8 persons/ha or >8 persons/ha) and associations with nutritional status of mothers and children were explored. Ownership of livestock is another important resource for agricultural communities in Ethiopia. To group households based on size of livestock they owned, the livestock data (type and number of livestock owned) was converted to a Tropical Livestock Units (TLU) equivalent (1 TLU is generally estimated to be equivalent with 250 kg livestock). Accordingly, conversion factors vary depending on the weight of the specific animal or the region. For this study, the following conversion factors were used: 1 cow/ox = 1TLU, 1 goat/sheep = 0.13TLU, 1 donkey = 0.7TLU, 1 horse/mule = 1.1TLU, and 1 chicken = 0.013TLU. Conversion factors used here were obtained from previously published sources which used similar conversion factors in studies done in Ethiopia (Storck, Emana, Adinew, Borowiecki, & W/Hawariat, 1991; Teshome, Kassa, Emana, & Haji, 2013). After calculating total TLU for each household, household were then grouped into low (<2.5 TLU), medium (2.5- 5 TLU) or high (>5 TLU) categories.

A wealth index (WI) was also developed for each participating household to categorize households' socioeconomic status. To achieve this, various assets owned by households, housing and sanitation related characteristics (a total of 13 binary variables) were used. These include ownership of radio, TV, mobile phone, bicycle, horse/donkey cart, motorcycle, handheld torch and oxen. Housing characteristics used in WI were roofing structure (corrugated iron or thatched grass roof), flooring materials[8] (dung/cement or earth/sand), presence or absence of windows, crowding (persons per sleeping room ≤5 or ≥6) as well as presence or absence of an improved sanitation facility. Various methods can be used to weigh each item (in this case, all binary variables) and calculate the actual index (Howe, Hargreaves, & Huttly, 2008). For this study, each household received a score of "1" or "0" depending on whether it had the particular asset or characteristics. Then each binary variable was weighted by the inverse of the proportion of households that owned the particular item or had the particular characteristics. This method assumes that if assets are owned by just the "few", it indicates that those 'few' are, perhaps, wealthier than those that do not own the asset, hence they are given greater weight. Households were then grouped into low (<4), medium (4-8) and high (>8) WI categories.

Trained female data collectors (mainly nurses) who spoke the local languages fluently administered the interview questionnaire at participants' residence. Data collection was supervised by the principal investigator (GE) and B.Sc. nutrition graduates who also spoke the local language fluently. Anthropometric measurements of mothers along with their children were carried out at the nearest health facility or local school compound. One anthropometrist (GE) conducted all maternal and child anthropometry to avoid inter-measurer errors. Child anthropometry included weight (measured to the nearest 10g) using electronic scale (Seca 770, Seca Corpo- ration, Hanover, MD, USA); height/recumbent length (measured to the nearest 0.1cm) using adult/infant length/stature measuring board (Perspective Enterprises, Portage, MI, USA); head circumference (measured to the nearest 0.1cm) using a flexible non-stretch tape; mid-upper arm circumference (MUAC) (measured to the nearest 0.1cm) using colored insertion tape for children; and triceps skinfold thickness (measured to the nearest 0.2mm) using skinfold caliper (*Holtain* Ltd, Crymych, United Kingdom). Mothers' anthropometry included weight (to

[8] For this dichotomous variable, households with cemented floor (which were <1%) were merged with those having a cow-dung smeared floor and were given a score of "1" while all other households with mud/sand floor were given a score of "0".

the nearest 0.1kg), height (to the nearest 0.1cm) and MUAC (to the nearest 0.1cm). All measurements were taken in duplicate and averages were considered if the values were similar. If the values were not similar, an additional measure was taken and the two similar values were averaged. Standardized procedures were employed when taking body measurements (3, 23). Birthdates for children were determined from immunization cards while mothers were asked for their age verbally.

All questionnaires were inspected daily and errors or inconsistencies were corrected at the field level. Information from questionnaire was entered into SPSS computer package (IBM SPSS Statistics version 20, IBM Corp., Armonk, NY, USA) and cleaned by running simple frequency distributions. Univariate and bivariate analyses were performed to present findings in descriptive statistics. Associations of gender and socioeconomic-demographic variables in relation to maternal and child undernutrition (i.e., BMI< 18.5 and LAZ< -2SD, respectively) were explored using *Chi square tests*.

WHO Anthro (ver. 3.2.2) 2011 was used to analyse all anthropometric data for children. Mean length-for-age z-score (LAZ), weight-for-length z-score (WLZ), weight-for-age z-score (WAZ), MUAC-for-age z-score, head circumference-for-age z-score, triceps skinfold thickness-for-age z-score (only for children ≥ 3 months) and BMI-for-age z-score were calculated for three age groups of the study children; differences were tested using *t-test for independent samples*. Prevalence of stunting (LAZ<-2 Standard Deviation, SD), wasting (WAZ <-2SD) and underweight (WAZ<-2 SD) were calculated. Body measurements from mothers were directly entered into SPSS spreadsheet and average MUAC, weight, height as well maternal short stature (as %<145cm) were calculated (WHO Expert Committee on Physical Status, 1995). Body Mass Index (BMI) of non-pregnant mothers and levels of maternal undernutrition were estimated according to WHO classification of BMI (i.e., <18.5 = underweight, 18.5-24.9 = normal and >25 = overweight/obese). Since MUAC is relatively stable during pregnancy (Gibson, 2005b), all mothers in the study (including pregnant ones) were grouped as undernourished (MUAC <23cm) or normal (MUAC ≥23cm) as cut point.

Where possible, results were presented along with findings from national/regional studies for comparison purpose. Statistical significance was set at a *p*-value of < 0.05.

4.3. Results

4.3.1. Household structure: Socioeconomic and demographic characteristics

Individual and household related background characteristics of participants are presented in Table 4.1. Similar demographic characteristics were observed in both study areas: Average maternal age (28y) and household size (6 persons), as well as having two or more under 5y of age children (43.8% in Halaba and 38% in Zeway) were comparable in both communities. The average household size reported was larger than the national average. Almost all mothers were married and polygamy was a common practice, particularly in Halaba where one in four mothers had polygamous husbands compared with one in ten at the national level. Compared with the national report, school attendance was much lower among the women. However, their husbands, particularly in Zeway, attended some primary (Grade 1-6) and post primary education.

Table 4.1 also shows that male-headship was very prominent in the study areas. Ninety percent of the women were not involved in any income generating activities (i.e., they were housewives). Farming was the main occupation of their husbands. Stand-pipe/public tap and well were the main sources of water (91% - 96% of the time) for households (data not shown). Fetching water was primarily women's responsibility.

4.3.2. Maternal and child anthropometry and levels of undernutrition

Tables 4.2 and 4.3 present information based on maternal and child anthropometric measurements. Mothers in Halaba were taller (157.2cm) than those in Zeway (155.6cm) ($p < 0.05$), but had similar average MUAC as Zeway mothers (25cm) (Table 4.2). Excluding pregnant mothers and those who had babies within the two months preceding the measurement, the average maternal weight was not different while average BMI was slightly lower in Halaba than Zeway mothers ($p < 0.05$). Prevalence of maternal short-stature (≤145cm) were 1% to 5%, comparable to the national prevalence of 4%.

Maternal undernutrition (% BMI <18.5) was 22% in Halaba and 14% in Zeway. The majority of the mother fell in the normal BMI range. When MUAC was used to estimate proportion of undernourished mothers (MUAC< 23cm) 27% of Halaba and 24% of Zeway mothers fell in the undernourished category. However, no significant differences were observed between communities in proportion of undernourished mothers using either BMI or MUAC ($p > 0.05$).

Table 4.1 Socio-demographic characteristics of study participants from two rural communities in Halaba and one rural community in Zeway, Ethiopia, 2013 [a]

	Halaba (GS & HK) n=413	Zeway (EQ) n= 217	National/regional reports [b, c]
Mean (SD)			
Maternal age	28.2 (5.66)	28.3 (6.1)	-
Household size	5.9 (1.90)	6.3 (2.2)	4.9
Under 5 children/family (%)			
One	56.2	61.8	-
Two or more	43.8	38.2	-
Marital status (%)			
Married	98.1	94.9	58.1
Other [d]	1.9	5.1	14.8
Mothers in polygamous family (%)			
Yes	26.6	18.4	11.6
Mothers' formal education (%)			
No formal education	80.4	70.5	59.8
Primary	16.2	22.6	34.5
Post primary	3.4	6.9	3.7
Husbands' formal education (%)			
No formal education	53.8	29.5	35.7
Primary	31.5	44.7	56.3
Post primary	14.7	25.8	8.0
Head of HH (%)			
Husbands	89.6	93	76.8
Women	10.4	7	23.2
Mothers' usual occupation (%)			
Housewife	93.5	89.4	-
Petty trading	4.1	5.1	-
Others [e]	2.4	5.5	-
Husband's occupation (%)			
Farmer	90	89.7	87.9
Other [e]	10	10.3	10.1
Person responsible for fetching water (%)			
Women (mothers)	69	65	70.7
Husband	5.3	10.1	7.3
Children	21.5	16.1	19.8
Maid and Other [f]	4.1	8.8	0.9

Abbreviations: GS= Guba-Sherero, HK= Holagoba-Kukie, EQ= Edo-Qontola; SD= Standard deviation; HH= Household; EDHS= Ethiopian demographic and health survey; EHNRI= Ethiopia health and nutrition research institute; [a] n=630; [b] EDHS (CSA & ICF International, 2012); [c] comparison figures represent rural population; [d] Divorced, widowed, separated; [e] Other= civil servant, agricultural laborer, tenant farmer and daily laborer; [f] Employed/rented donkey cart;

Mean Z-scores of various anthropometric indicators of children, particularly the ones measuring height/length-for-age and weight-for-age were as low as -2.1 and -1.6, respectively, in

Halaba and were significantly lower than the respective values for Zeway children ($p < 0.001$) (Table 4.3).

Prevalence estimates of undernutrition in children <5y of age particularly, stunting (54%) and underweight (36%) were very high in Halaba communities. The respective findings for children in Zeway community were 42% and 21%, still high but significantly lower compared with estimates for Halaba children ($p < 0.05$). The values for Zeway children were lower than those reported at national level, whereas stunting and underweight in Halaba were 20% and 26% higher than the national estimates.

Table 4.2 Anthropometric measurements and associated indices for mothers from rural communities in Halaba and Zeway area, Ethiopia, 2013

	Halaba (GS & HK)	Zeway (EQ)	National/Regional Reports [a]
Mean (SD)	n=341	n=162	
Height (cm)	157.2 (5.8) [b]	155.6 (6.4)	-
MUAC (cm)	24.6 (2.4)	25.1 (3.3)	-
	n=266	n=142	
Weight (kg) [c]	50.3 (6.7)	51.3 (8.7)	-
BMI (kgm^{-2}) [c]	20.3 (2.1) [b]	21.2 (3.6)	20.2
Maternal stature categories (%)	n=341	n=162	
Height < 145 cm	1.2	4.9	3.4
Height 145-150 cm	9.1	10.5	-
Height > 150 cm	89.7	84.6	-
Body mass index [a] (kg/m^2) categories (%)	n=266	n= 142	
Underweight (BMI < 18.5)	21.8	14.1	26.9
Normal range (BMI 18.5-24.99)	75.6	77.5	67.4
Overweight/obese (BMI > 25.0)	2.6	8.4	5.7
Undernutrition based on MUAC (%)	n=341	n=163	
Undernourished (< 23 cm)	27	23.5	-
Normal (≥ 23 cm)	73	76.5	-

Abbreviations: GS=Guba-Sherero; HK= Holagoba-Kukie; EQ= Edo-Qontola; SD= Standard deviation; MUAC= Mid-upper arm circumference; BMI= Body mass index; EDHS= Ethiopia demographic and health survey; [a] EDHS (CSA & ICF International, 2012);
[b] significant at $p < 0.05$ *(independent t-test)*; [c] excludes pregnant mothers, pregnant and lactating mothers and mothers who had babies with in the last two months prior to the anthropometric measurement;

Gender disaggregated prevalence of child undernutrition showed no significant difference in prevalence of stunting, wasting and underweight between males and females within communities. However, more stunted (55.1%) and underweight (33%) female children resided in

Halaba than Zeway (36.3% and 20.9 %, respectively) (p < 0.05). Among male children, more wasting and underweight were found in Halaba than Zeway.

Table 4.3 Anthropometric measurements and associated indices for <5years of age children from rural communities of Halaba and Zeway areas, Ethiopia, 2013

	Halaba (GS & HK)	Zeway (EQ)	National/ Regional Reports [a]
Mean (SD) z-scores	n=355	n=170	
Length/height-for-age	-2.1 (1.6) [b]	-1.6 (1.6)	-1.7
Weight-for-length/height	-0.5 (1.2)	-0.32 (1)	-0.5
Weight-for-age	-1.6 (1.4) [b]	-1.1 (1.2)	-1.3
BMI-for-age	-0.4 (1.2) [c]	-0.13 (1)	-
Head circumference (cm)	45.2 (3.4) [b]	47.2 (2.7)	-
Head circumference-for-age	0 (1.2)	-0.03 (1.2)	-
	n=301 [d]	n=165 [d]	
MUAC (cm)	13.1 (1.2) [c]	13.6 (1.3)	-
MUAC-for-age	-1.5 (1.1)	-1.4 (1)	-
TSF thickness (mm)	8.5 (1.7)	8.3 (1.7)	-
Triceps skinfold-for-age	0.1 (1)	-0.03 (1)	-
Prevalence estimates (%)	n=355	n=170	
Stunting (HAZ <-2SD	53.5 [e]	41.8	44.4
Wasting (WHZ<-2SD)	10.4 [e]	4.1	9.7
Underweight (WAZ<-2SD)	36.3 [e]	21.3	28.7
	n=315 [d]	n=169 [d]	
MUAC-for-age < -2SD	30.2	24.9	-
Gender disaggregated prevalence of undernutrition (%)	n=355	n=170	
Stunting			
Male	52	48.1	46.2
Female	55.1[e]	36.3	42.5
Wasting			
Male	12.8 [e]	3.8	11.1
Female	8	4.4	8.2
Underweight			
Male	39.7 [e]	21.8	30.5
Female	33.0 [e]	20.9	26.8

Abbreviations: GS=Guba-Sherero; HK= Holagoba Kukie; EQ=Edo-Qontola; MUAC= Mid-upper arm circumference; TSF= Triceps skinfold thickness; HAZ= Height-for-age Z-score; WHZ= Weight-for-height Z-score; WAZ= Weight-for-age Z-score; SD=Standard deviation;
[a] EDHS (CSA & ICF International, 2012); [b] and [c] significant between Halaba and Zeway at p < 0.001 and p < 0.05, respectively, *(independent t-test);* [d] Minimum child age for the anthropometric indices in these groups is 3 months; [e] significant between Halaba and Zeway at p < 0.05 *(χ^2-test);*

4.3.3. Access and utilization of health services, dietary habits and food taboos during pregnancy and lactation

During their most recent pregnancy, most mothers from each location attended a Health Post [9] or Health Centre [10] (depending on proximity) for their antenatal care (ANC). Higher proportion of Zeway mothers not only had greater number of ANC visits (4-5 times) but also visited Health Centre. Hospital use for ANC was very minimal or nonexistent in both Halaba and Zeway. Delivery of babies at a healthcare-facility was very minimal, particularly in Halaba. More mothers in Halaba than Zeway reported receiving iron/folate supplement during pregnancy. However, 77% Zeway and 41% Halaba mothers did not get health/nutrition education before or after delivery of their youngest baby. The practice of avoidance of certain foods (mostly animal source foods) for cultural reasons (food taboos) were more common in Halaba (61%) than Zeway (18%) ($p < 0.001$). Majority mothers (96% in Halaba and 85% in Zeway) said they ate the 'same as usual' or 'less than usual' during their pregnancy. In a follow up open ended question, 'poor appetite' and 'feeling nauseated/sick' followed by 'inability to afford desired food' were most frequent reasons mothers gave for not eating more during pregnancy. Whereas, 'increased appetite due to lactation' was the most frequent reason mother gave for reportedly eating more during lactation. In Halaba, only one in four mothers knew what a balanced diet was compared with two in four in Zeway.

4.3.4. Associations of gender, household structure, access and utilization of health services and diet related variables with maternal and child undernutrition

Table 4.5 presents Chi-square associations of various gender and household structure related variables with maternal undernutrition (% BMI <18.5) and child stunting (% LAZ<-2SD). Empowerment index significantly associated with child stunting ($p < 0.05$) but not with maternal undernutrition. Women's access to their own piece of land did not significantly associate with either maternal or child undernutrition. Stunting did not vary significantly between households where only men versus both men and women controlled agricultural produce. Other gender related variables, such as work burden of women, presence or absence of

[9] Health Post is a component of primary health care unit introduced as part of the first Health Sector Development Plan and provides basic preventive/ promotive health care mostly for the rural population of Ethiopia;

[10] Health Centre is also part of primary health care unit and severs as a referral for health posts and provides curative services to common diseases.

Table 4.4 Access and utilization of health/nutrition services, and dietary habits during most recent pregnancy of mothers from rural communities of Halaba and Zeway area, Ethiopia, 2013 [a]

	Halaba (GS & HK)	Zeway (EQ)	National/Regional reports
ANC facility attendance (%)	n=413	n= 217	
Did not go anywhere	11.4	17.1	-
Health Post (HEW)	39.2	2.3	40.9 [b]
Health Center (nurse/midwife)	49.4	78.3	-
Hospitals (Doctor/nurse/ midwife)	0	2.3	48.4 [b]
ANC visits during last pregnancy (%)	n=409	n= 217	
< 4 ANC visits	70.5	64.1	63.7 [c]
4-5 ANC visits	25.9	35.9	14.0 [c]
6 and above ANC visits	3.7	0.0	22.3 [c]
Received iron/folate supplement during last pregnancy (%)	n=412	n= 217	
Yes	72.6	51.6	15.1 [c]
Place of delivery of youngest child (%)	n=412	n= 217	
Own home	90.3	82.0	95.7 [c]
Health facility	8.9	17.9	4.3 [c]
Received any health/nutrition education during/after last pregnancy (%)	n=413	n= 217	
Yes	58.8	23.5	-
Stopped eating certain foods during pregnancy for cultural reasons (%)	n= 412	n= 217	
Yes	61.4 [d]	18.0	-
Consumption pattern during last pregnancy (%)	n= 411	n= 214	
More than usual	4.6	15.4	9.1 [c]
Same as usual	19.5	54.7	28.1 [c]
Less than usual	75.9	29.9	55.4 [c]
Eating pattern during lactation (%)	n= 410	n= 215	
More than usual	75.6	55.3	-
Same/less than usual	24.4	44.7	-
Knowledge of balanced diet (%)	n= 411	n=215	
Yes	24.0	58.6	-

Abbreviations: ANC= Antenatal clinic; HEW= Health extension workers; GS= Guba-Sherero, HK= Holagoba Kukie, EQ= Edo-Qontola; [a] n=630; [b] EDHS (CSA & ICF International, 2012); [c] EHNRI (EHNRI, 2010); [d] significant at $p < 0.001$ *(χ^2 test)*;

polygamy in the home and headship of household, did not show significant association with maternal and child nutritional status in this study. Having a household size of <6 or ≥6 persons significantly associated with maternal undernutrition ($p < 0.05$) and child stunting ($p < 0.05$). Physiological density also significantly associated with child stunting ($p < 0.05$) but not with

Table 4.5 Association of gender, household structure and location related variables to maternal undernutrition and child stunting in rural Halaba and Zeway, Ethiopia (2013)

	Maternal undernutrition (% BMI < 18.5 kgm^{-2})			Child stunting (% HAZ <-2SD)		
	No	Yes	χ2 (*p*-value)	No	Yes	χ2 (*p* value)
Empowerment index [a]		n=408			n=525	
< 0 [b]	41.7	8.3	χ2 =2.971	24.2	26.9	χ2 =8.694
0-2	6.4	2.5	*p* = 0.396	5.9	2.5	*p* = 0.034
3-5	18.6	5.1		12.6	11.6	
> 5	14.2	3.2		7.6	8.8	
Women with access to own land		n=401			n=519	
No	58.6	14.2	χ2 =0.003	38.3	35.1	χ2 =2.162
Yes	21.9	5.2	*p* = 0.954	11.9	14.6	*p* =0.142
Control of farm produce		n=316			n=414	
Men	68	20.3	χ2 =1.7	42.5	46.9	χ2 =0.767
Women or both	10.1	1.6	*p* = 0.192	5.8	4.8	*p* = 0.381
Work burden of women [c]		n=408			n=525	
Shorter distance (<30 minutes)	23.5	5.2	χ2 =0.145	15	13.7	χ2 =0.35
Longer distance (≥30 minutes)	57.4	14.0	*p* = 0.703	35.2	36	*p* =0.554
Polygamy		n=408			n=525	
No	63.7	14	χ2 =1.187	38.7	38.9	χ2 =0.121
Yes	17.2	5.1	*p* = 0.276	11.6	10.9	*p* = 0.728
Household headship		n=407			n=522	
Men	74.2	16.7	χ2 =1.624	46.4	44.6	χ2 =0.672
Women or both	6.6	2.5	*p* = 0.203	4	5	*p* = 0.412
Household size		n= 408			n=525	
< 6	31.4	9.6	χ2 =3.28	19	23.8	χ2 =5.374
≥ 6	49.5	9.6	*p* = .047 [e]	31.2	25.9	*p* = 0.02
Physiological density [d]		n=387			n=497	
8 or less	49.9	11.6	χ2 =0.088	34.6	29.4	χ2 =5.615
>8	30.7	7.8	*p* = 0.766	15.5	20.5	*p* =0.018
Household TLU		n=408			n=525	
Low (<2.5)	46.3	11.3	χ2 =0.145	29.7	28.4	χ2 =2.931
Average (2.5-5)	23.5	5.1	*p* = 0.93	13.3	16	*p* = 0.231
High (>5)	11	2.7		7.2	5.3	
Wealth index		(n=408)			n=523	
Low (<4)	23.2	5.2	χ2 =1.612	14.9	14.5	χ2 =2.867
Medium (4-8)	33.7	9.1	*p* = 0.447	20.3	22.9	*p* = 0.239
High (>8)	24.4	4.4		15.3	12	
Consumption pattern during pregnancy		n=406			n=521	
More than usual	6.7	1.7	χ2 =0.045	5.6	2.7	χ2 =5.517
Same/less than usual	74.1	17.5	*p* = 0.831	44.7	47	*p* = 0.019
Maternal knowledge of balanced diet		n=405			n=521	
No	51.4	10.6	χ^2 =1.517	31.1	32.2	χ^2 =0.364
Yes	29.6	8.4	*p*=0.218	19	17.7	*p*=0.546
Geographic location of households		n=525			n=525	
Halaba	51	14.4	χ2 =3.568	31.4	36.2	χ2 =6.355
Zeway	29.9	4.9	*p*=0.038 [e]	18.9	13.5	*p* = 0.012

Abbreviation: BMI= Body Mass Index; HAZ= Height-for-age z score; SD= Standard deviation; TLU= Tropical livestock unit; [a] measured using difference in men-women years of formal schooling as a proxy, [b] indicates households where women had more years of formal schooling than men; [c] measured using time required for fetching drinking water as a proxy; TLU= Tropical livestock unite; [e] *p*-value from *Fisher's exact test*;

maternal undernutrition. Households' economic structure variables (i.e., TLU of households and wealth index) did not significantly associate with either outcome. Maternal dietary habit during pregnancy (eating 'more than usual' or 'same/less than usual') significantly associated with child stunting ($p < 0.05$) and underweight ($p < 0.05$), but not with maternal undernutrition. Mothers' knowledge of balanced diet did not associate with undernutrition in either group. However, residing in Halaba or Zeway significantly associated with both maternal undernutrition ($p < 0.05$) and child stunting ($p < 0.05$).

Access and utilization of health-nutrition services (i.e., ANC attendance, number of ANC visits, place of delivery, receiving iron-folate supplement or health-nutrition education) and food taboos did not significantly associate with either maternal undernutrition or child stunting (result not shown). But abstinence from certain foods during pregnancy (food taboo) significantly associated with child wasting ($p = 0.024$) (data not shown).

4.4. Discussion

The study found an alarming level of child stunting in both study communities – 54% in Halaba and 42% in Zeway. The levels of maternal undernutrition ranged from moderate (14%) in Zeway to high (22%) in Halaba communities. The study also found that 95% of Halaba and 85% of Zeway mothers reported dietary consumption patterns that were 'same as usual' or 'less than usual' during their most recent pregnancy compared to times of non-pregnancy/lactation. The practice of food taboos was up to 61%. Gender and socioeconomic-demographic factors such as imbalance of power, physiological density, household size and dietary habits during pregnancy showed significant associations with maternal and/or child undernutrition.

According to current understanding, targeting the most vulnerable groups, such as pregnant-lactating mothers, adolescent girls, infants and young children, is one of the strategies to break the cycle of chronic undernutrition, with particular emphasis to the first 1000 days of life (Bhutta et al., 2013; Black et al., 2008; Black et al., 2013). In agreement to this, Ethiopia launched a National Nutrition Program (NNP) in 2008; the NNP was later revised with the intent to accelerate progress and achieve the Millennium Development Goals (Ethiopia Federal MoH, 2008b; FDRE, 2013). Reducing stunting from 46% to 37% was set as part of the country's five years (2010-2015) Growth and Transformation Plan (Ministry of Finance and Economic Development, 2010). To deliver the service from NNP, Ethiopia took advantage of the national

Health Extension Program which was already in place prior to the 2008 NNP with the purpose of improving access to basic health and nutrition services at grass root levels (Banteyerga, 2011). Nutrition specific and nutrition sensitive programs have been put in place through initiatives such as community-based nutrition and Agricultural Extensions Programs. As a result of these and other related initiatives, Ethiopia has experienced significantly reduced prevalence of stunting, wasting and underweight as well as low-birth-weight babies over the past few years (African Union Commission et al., 2014).

Despite these encouraging pro-nutrition environments, major findings of this study indicated presence of a serious public health concern in subpopulations and in parts of the country. The prevalence of maternal undernutrition reported here, though lower than the 27% national prevalence (CSA & ICF International, 2012), presents a continued challenge for the particular region. Level of maternal undernutrition in Ethiopia in 2011 DHS were nearly twice as high as those reported for neighbouring Kenya or Uganda in recent DHS (Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010; Uganda Bureau of Statistics (UBOS) & ICF International Inc., 2012). Maternal undernutrition, along with maternal short stature, is known to increase obstetric risks and maternal morbidity, even in the presence of adequate medical services (Villar et al., 2006). In addition, it is a known risk factor for Intra-Uterine Growth Restriction (IUGR), and subsequent low-birth-weight babies, with increased risk of neonatal mortality or stunting (Black et al., 2008; Kramer, 1987a, 1987b). An insult during fetal or embryonic development, according to the theory of fetal programing of chronic diseases, has also been linked to adult-diseases, such as coronary heart disease, hypertension, type-2 diabetes and high cholesterol (Godfrey & Barker, 2000, 2001; Miese-Looy, Rollings-Scattergood, & Yeung, 2008).

The alarmingly high levels of child stunting reported here are up to 50% - 80% higher compared with the levels in neighbouring countries Kenya and Uganda (Kenya National Bureau of Statistics, Ministry of Health, National AIDS Control Council, Kenya Medical Research Institute, & National Council for Population and Development, 2015; Kenya National Bureau of Statistics (KNBS) & ICF Macro, 2010; Matanda, Mittelmark, & Kigaru, 2014; Uganda Bureau of Statistics (UBOS) & ICF International Inc., 2012). The prevalence of underweight (a combined reflection of both stunting and wasting) in Halaba was 70% higher than the level found in Zeway community. Both stunting and underweight levels for Halaba children (Table 3) were not only higher compared with the corresponding values reported in 2011 at national level (CSA & ICF International, 2012) but also higher than what was reported in DHS 2005. Regardless of what the actual levels of undernutrition were for the study sites in 2005, the levels reported here alone warrant a serious warning for nutrition program implementers in the region. It was already established that stunting compromises both the physical and mental productivity of a country's future labor force (Black, 2005; Grantham-McGregor et al., 2007; Victora et al., 2008); hence the level of undernutrition reported here (over half) should raise a serious concern regarding the future productive force in the regions.

The fact wasting was relatively low (at least, in Zeway community, 4%) indicates that stunting was major contributor to the observed high or very high level of underweight. Stunting is a reflection of poor nutrition suffered for a long period of time as opposed to wasting, which reflects acute situation of poor nutrition from primary or secondary causes. Addressing wasting in children need not be neglected; but health and nutrition programs need to be specific enough to address stunting. Previous similar studies in younger children (<2y or 3y of age) from adjacent regions of south Ethiopia also reported high levels of child stunting but not as high as levels in reported here (Gibson et al., 2009; Kebebu et al., 2013; Tessema et al., 2013). High levels of stunting (31 %) were also reported among adolescent girls in Halaba area in a recent community-based study (Roba et al., 2015).

The gender disaggregated data for the prevalence of stunting, wasting and underweight among under 5y of age children did not show significant difference between boys and girls indicating that both boys and girls were equally vulnerable to poor nutrition at younger age and there was no differential vulnerability based on gender (result not shown). However, there were 12% higher stunted boys than girls from the Zeway community (p=0.08).

Poor nourishment and/or health are the immediate causes of either maternal or child undernutrition. However, women and young children are surrounded by a host of underlying and basic factors in their physical and social environment that may affect their nutrition and health. These factors, often referred to as *social determinants of health* (Commission on Social Determinants of Health, 2008), may greatly impact the growing environment of children. Access and utilization of health/nutrition services may affect maternal and child nutritional status as most mothers in Ethiopia live in rural areas where information/services on nutrition/health are limited. Children are more vulnerable to effects of less optimal environment partly because they depend on adults, mostly women, for necessary care. Hence, the adequacy of care women are able to provide to children is affected by their own status—gender related factors, such as their level of empowerment, access-control of important resources and the work-burden they shoulder. In addition, household level factors such as 'number of people in the household', wealth, and ownership of livestock are also factors capable of modifying health/nutrition environment for children and women. The socioeconomic and demographic characteristics presented in Table 1 (such as, low literacy levels, patriarchal family structure, farming as main livelihood and large household size) follow similar trends as in DHS and other local studies (CSA & ICF International, 2012; EHNRI, 2010; Gibson et al., 2009; Regassa & Stoecker, 2012b).

Many of these factors, presented in Table 5, did not show significant associations with maternal nutritional status except household size (number of persons in the house). This indicates the possible effect of larger family size in putting pressure on women as they carry out their biological role of bearing and rearing children which in turn is exacerbated with larger family size. Empowerment index—a gender related proxy variable estimated by difference in years of formal schooling between husband and wife—significantly associated with child stunting. The use of years of formal schooling to measure empowerment is supported in literature (Groot & van den Brink, 2002; Guha-Khasnobis & Hazarika, 2006). The proportion of stunted children was the smallest (2.5%) in households where the difference in empowerment was the least. This might imply that imbalance in empowerment affects decision making and communications in the household, which in turn impact child caring practices. Women's empowerment and nutrition have been shown to have positive relationships with child health and nutritional status. In a review of current literature, maternal autonomy/decision making power was associated with better child feeding practices and child nutritional status (Carlson, Kordas, & Murray-Kolb, 2015). A positive association of women's empowerment and maternal-child health outcomes was also shown in another systematic review of studies from developing countries (Pratley, 2016). A review study in 10 sub-Saharan African countries, including Ethiopia, showed that women's empowerment in general was linked positively with specific IYCF practices (Na, Jennings, Talegawkar, & Ahmed, 2015).

Likewise, high physiological density may mean less food produced to feed members of the household, hence implication to child nutritional status. Either or both large family size and smaller farm-land holding contribute to high physiological density. This challenge can be mitigated by improved population policy (improved reproductive health services to limit unintended pregnancies) and a strong agriculture policy that improves productivity in a small plot of land. Both physiological-density and household size have shown significant association with child undernutrition in this study.

Another important variable that showed an association with child stunting is how mothers ate during their most recent pregnancy. Diet during pregnancy affects maternal health status and child development at early stages. Earlier studies looked into factors dictating human growth process in infancy, childhood and puberty, and showed that growth in infancy and early childhood is ‘nutrition driven’ while growth in the later stages are ‘hormone driven’(Tse et al., 1989). Some also added that growth at the early stage of infancy is simply ‘a post-natal continuation of fetal growth’ (Karlberg, 1989). Maternal undernutrition and poor dietary habit during pregnancy was a known risk factor for intrauterine growth restriction and poor pregnancy outcome (low-birth-weight), both of which were shown to be major risk factors for childhood stunting (Bhutta et al., 2008; Black et al., 2008; Kind et al., 2006; Kramer & Kakuma, 2003; Ota et al., 2011). Besides abstaining from consumption of certain nutritious foods during pregnancy, a large majority (85% -95 %) of mothers in this study reported consuming ‘as usual’ or ‘less than usual’—mainly due to poor appetite/feeling of nausea followed by poor access to desired food—during this critical period (table 4). The finding on poor dietary practice during pregnancy was not only consistent with the national report in 2009 (EHNRI, 2010) but also was an indication of possible lack of improvement in this arear five years after the launch of the NNP. Though we were unable to connect poor diet during pregnancy and birth-weight in our communities (as ~90% birth happened at home), the very high levels of child stunting and moderate to high levels of maternal undernutrition reported here indicate the poor growing environment available for the children to thrive. These evidence again call for more focused nutrition/health services and improved utilization of these services by mothers and children in the study communities and similar settings should the country sustain progress in the reduction of undernutrition toward achieving the new sustainable development goals (United Nations, 2016).

4.5. Conclusion

This study has found very high levels of child stunting (up to 54%) and underweight (up to 36%). It also reported moderate to high levels of maternal undernutrition. Gender as well as socioeconomic and demographic factors, such as empowerment imbalance, physiological density, household size and dietary habits during pregnancy, have shown significant associations with maternal and child undernutrition, warranting further investigation. The poor dietary habit, including food taboos, of the women during pregnancy is also concerning and calls for the attention of health program implementers in the region to address this issue with proper nutrition education given pregnancy is a critical stage of life for both the mother and the fetus. Overall, this baseline study provides feedback for government and non-governmental agencies providing nutrition services in these communities to evaluate the effectiveness of their programs and strengthen efforts in reaching out these most vulnerable segment of the population.

Chapter 5 Suboptimal feeding practices and high levels of undernutrition among infants and young children in the rural communities of *Halaba* and *Zeway*, Ethiopia (Study 2)

Abstract

Good nutrition and appropriate child feeding are vital in early stages of child development particularly in the first 1000 days of life. Assess the adoption of infant and young child feeding practices of World Health Organization, dietary intakes and level of undernutrition in children <2 years of age. Baseline cross-sectional study was conducted (January-June 2013) in purposively selected rural communities of *Halaba* and *Zeway*, Ethiopia (n=383 mother-child pairs, randomly selected). Overall prevalence of stunting, wasting and underweight were 45%, 9% and 28% *Halaba* and 33%, 7% and 15% in *Zeway*, respectively; higher levels of stunting (54% *Halaba* and 36% *Zeway*) were observed in 6-24 mo; stunting and underweight, but not wasting, differed by age ($p < 0.001$) in *Halaba*. Median Dietary Diversity Score in both communities was two with 61-65% of children consuming 0-2 food groupings. Except protein in all age and iron in 12-24 mo, median intakes of energy, iron, zinc and calcium (and associated nutrient densities) were below estimated needs that should come from complementary foods in both communities (in sub-sample). Early initiation of breastfeeding and exclusive breastfeeding were 63%* and 86% in *Halaba* and 92% and 93% in *Zeway*, respectively ($^{*}p < 0.001$). Children receiving minimum acceptable diet were 6% and 9% in *Halaba* and *Zeway*, respectively. The high levels of stunting and suboptimal feeding practices, as well as low dietary diversity scores, energy and nutrient intakes in both communities, particularly in *Halaba*, indicate a need to improve/strengthen nutrition strategies for complementary-feeding children in these areas.

Keywords: Suboptimal feeding practices, Infant and Young Child Feeding, Complementary feeding, Stunting, Diet diversity, Ethiopia

5.1. Introduction

Appropriate feeding of children, as per World Health Organization (WHO) recommendations and with control of infectious disease, has been promoted as one strategy to combat growth faltering and associated consequences in young children (Bhutta et al., 2008; Bhutta et al., 2013). WHO has provided specific recommendations and a set of indicators on appropriate practices of infant and young child feeding (IYCF) (Pan American Health Organization & WHO, 2003; WHO, 2008; WHO & UNICEF, 2003). The recommendations emphasize initiating breastfeeding within one hour after birth, exclusively breastfeeding infants during the first six months as well as timely introducing adequate and safe solid/semi-solid foods—complementary foods—while continuing to breastfeed until two years or beyond (Pan American Health Organization & WHO, 2003; WHO & UNICEF, 2003). Earlier, exclusive breastfeeding alone has been estimated to prevent 1.2 million child deaths yearly worldwide (UNICEF et al., 2010). Continuing breastfeeding until 24 months of age, along with other appropriate foods, was also suggested to further improve health and growth in millions of children with significant reduction in morbidity and mortality (Bhutta et al., 2008; Jones et al., 2003; Victora et al., 2000). Recent reviews estimated 823,000 child deaths that could be prevented yearly through scaling up optimum breastfeeding to near universal coverage (Black et al., 2013; Victora et al., 2016). This makes the first two years, specifically the first 1000 days, of life very critical for interventions that aim to avert growth faltering (6) and associated consequences in young children.

Despite significant efforts to combat childhood malnutrition, very high level of child stunting—an indicator of chronic undernutrition—is still prevalent in Ethiopia. In 2009, Ethiopia had one of the highest rates of child stunting in Africa with an estimated 6.7 million stunted children under the age of five (UNICEF, 2009). Results from the 2011 Ethiopian Demographic and Health Survey (EDHS) were also worrisome as rates of stunting, wasting and underweight remained high at 44.4%, 9.7% and 28.7%, respectively (CSA & ICF International, 2012). According to the 2014 Mini-EDHS, stunting has dropped to 40.1% (CSA, 2014)—a reduction of about 1% per year but was insufficient to meet the National Nutrition Program target of reducing stunning to 30% by 2015 (FDRE, 2013).

Since linear growth faltering among infant and young children is the highest in the first two years of life (Victora et al., 2010), interventions focusing on appropriate feeding practices during this critical period have been recommended as key strategies to prevent stunting and associated mortality and morbidity. To this end the Ethiopian government, through the national health extension program, and the Alive & Thrive project (since 2009), have been extensively promoting appropriate IYCF practices for children <2 years of age (Alive & Thrive, 2014). A 2011 IYCF study in part of southern Ethiopia had shown poor compliance to WHO feeding practices and higher rates of impaired growth among complementary feeding children (i.e., 43% and 39% stunting in 6-8 and 9-23 months respectively, compared with 26.6% in 0-5 months) (Tessema et al., 2013). Studies in other parts of Ethiopia also showed low adherence to the WHO breastfeeding or complementary feeding recommendations; complementary foods were of low micronutrient content and below minimum diversity and meal frequency (Beyene, Worku, & Wassie, 2015; Gibson et al., 2009; Tadele, Habta, Akmel, & Deges, 2016; Tamiru et al., 2012).

However, there were no prior studies on IYCF practices in rural communities of Halaba district and Zeway areas. These areas were chosen purposively as part of a collaborative project between Hawassa University and University of Saskatchewan aimed at improving human nutrition through agricultural productivity. The study communities were both rural but in different administrative regions; Halaba is also traditionally a pulse growing district unlike the community from Zeway area which is mainly cereal growing. We therefore conducted the current study to assess the adoption of IYCF practices, as per WHO recommendations, and estimate prevalence of undernutrition among children <24 months using anthropometric and dietary assessments in these communities.

5.2. Methods

5.2.1. Study setting, participants and design

Between January-June 2013, baseline data were collected as part of a proposed community-based intervention study in purposively selected rural communities from *Halaba* and *Zeway*. *Halaba Woreda* is one of the eight special Woredas (~ district) in Southern Nations, Nationalities and People’s Region (SNNPR) and is located 315 km south of *Addis Ababa* and 85 kilometers northwest of *Hawassa*, the capital of SNNPR. The Woreda shares border with Oromiya Regional State (ORS) in the west, *Hadiya* Zone in the north and *Kembata Tembaro* Zone in the east. The district is known for growing peppers and pulses which are also considered cash crops by the local farmers. The other rural community from *Zeway* is part of *Adami Tulu*

Jido Kombolcha district in ORS. This district is situated on the main road connecting *Addis Ababa* to *Hawassa.* It is also located ~160 km southeast of *Addis Ababa* and shares border with *Dugda Bora* district in the north, SNNPR in the west, *Arsi Negelle* district in the south and *Arsi* Zone in the east. Maize, teff, wheat, barley and different oil seeds are the major agricultural crops produced in the district.

In consultation with the respective agricultural offices in the two districts, two rural *kebeles*[11] (communities), *Guba-Sherero* and *Holagoba-Kukie, from Halaba,* and one rural community from *Zeway*, *Edo-Qontola,* were selected for a bigger interventional study in these areas. However, the current study included data for children under two years of age (0-24 months) only. Using the formula for estimating sample size for cross-sectional survey design (Chadha, 2006; Fisher et al., 1998), 413 and 217 mother-child pairs, with children up to five years of age, were randomly selected from eligible households in *Halaba* and *Zeway* communities, respectively.

Inclusion criteria were: households having at least one apparently healthy (able to come out for body measurements) under 5 years of age child, be resident of the selected community, and the child should be living with the mother. In cases of >1 under 5 years of age children per household, only the youngest was included in the study. In cases of twin[12] children, one was randomly picked. The exclusion criterion was child experiencing serious sickness (such as diarrhea) in the two weeks prior to or at the time of the study. From these 630 mother-child pairs, 383 households (287 from *Halaba* and 96 from *Zeway*) with infant and young children <24 months and who met the inclusion criteria participated in this study (Figure 5.1).

5.2.2. Data collection, tools and analysis

Demographics and feeding practices: Trained female data collectors (mainly Nurses), supervised by the lead investigator [Getahun Ersino (GE)] and nutrition graduate Research Assistants, collected all questionnaire-based data and a single day in-house weighed food record.

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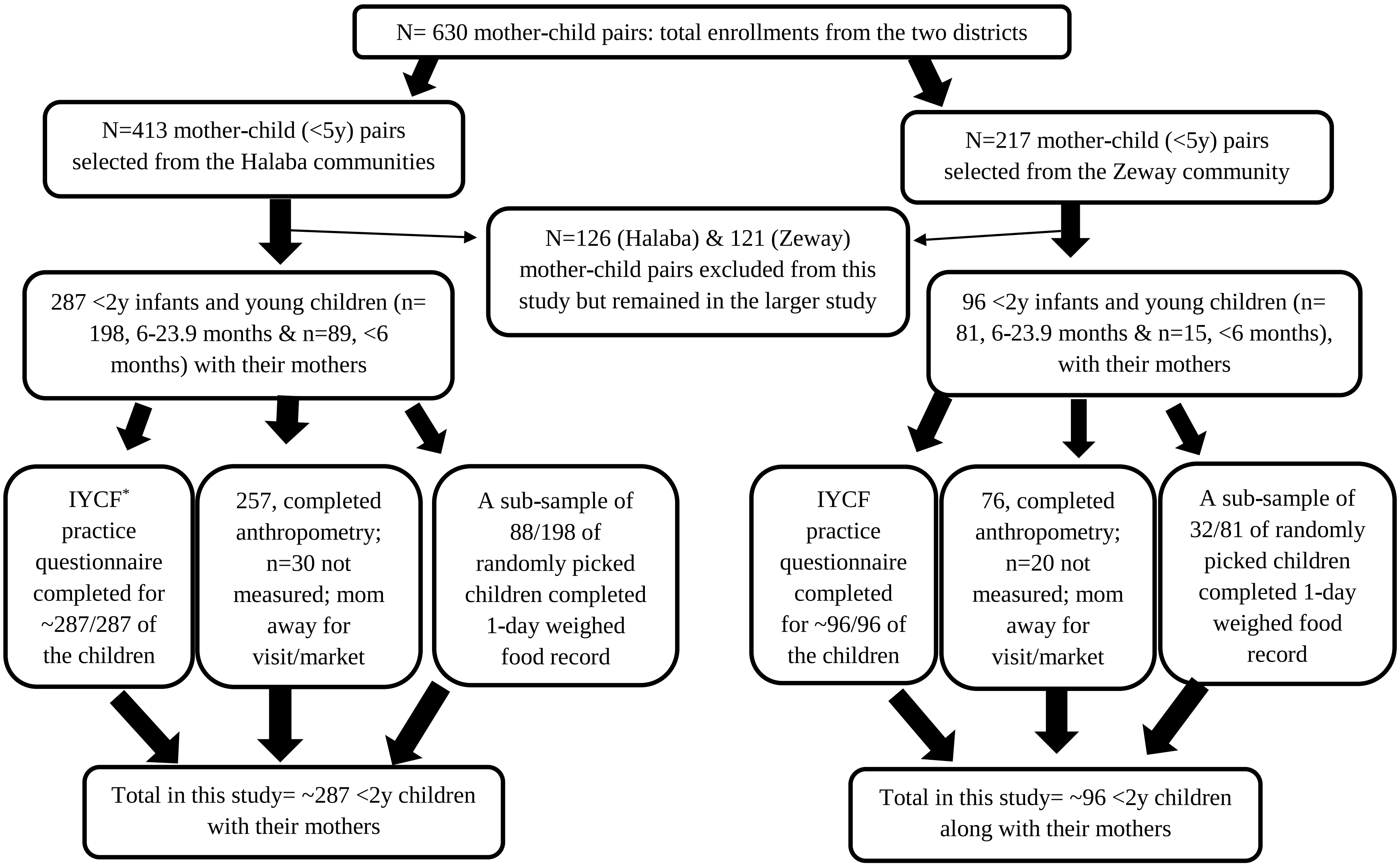
[11]*Kebeles* (referred as communities in this paper) are the smallest administrative units in the government structure and may contain about 500 households each. Each *Kebele* can be subdivided into smaller sub-units/sub-kebeles called ‘Got’.

[12] In the current study communities, only one household was found with twin children< 5 years of age.



**IYCF, Infant and Young Child Feeding*

Figure 5.1 Flow chart showing recruitment of participants in the study

Questionnaire adapted from a previous similar study in the region (Tessema et al., 2013) was used to collect information on background characteristics and IYCF specific variables. A 24-hours diet diversity questionnaire, prepared according to FAO guideline (Kennedy et al., 2011), was used to gather data for calculating Diet Diversity Scores (DDS) based on WHO seven food groups for complementary feeding children (6-23.9 months). The 7 food groups were ‘grains, roots and tubers’, ‘legumes and nuts’, ‘dairy products (milk, yogurt, cheese)’, ‘flesh foods (meat, fish, poultry and liver/organ meats)’, ‘eggs’, ‘vitamin-A rich fruits and vegetables’, and ‘other fruits and vegetables’ (WHO, 2008). Dietary diversity is generally a proxy measure for diet quality and micronutrient intakes.

Dietary intakes: Intakes of energy, protein, zinc, iron and calcium were measured in a sub-sample (n=88 in *Halaba*, n=32 in *Zeway*) of children receiving complementary feeding (i.e., only those between the age 6-23.9 months) from a single-day weighed-food record, collected on both week days and weekends to account for day of the week effect. About 8-10 data collectors started from a central location of each community and walked in different directions toward households already involved in the research. All participants had already been notified at the time of recruitment that, if selected for the weighted food record data collection, that a female data collector would come to their home to spend a day measuring their food intakes. Each data collector stopped by a participant’s household; checked if the age of participating child was between 6-23.9 months; and if so, the data collector would spend the entire day (from ~7:00am to ~7:00pm) recording everything the child consumed that day, with the exception of breastmilk. Data collectors were asked to skip households with children <6 months. Median intakes and nutrient densities (amount per 100 kcal of energy) were compared with estimated needs that should be obtained from complementary foods, assuming average composition and intake of breast milk for age. Median energy was compared with estimated needs from complementary foods as outlined in Dewey & Brown (Dewey & Brown, 2003) based on the Food and Agriculture Organization (FAO)/WHO/United Nations University (UNU) report (FAO, 2004), and also with age and weight adjusted estimated energy needs to account for size of our study children (Dewey & Brown, 2003; FAO, 2004). Estimated protein need was from WHO (WHO, 1998) and those for iron, zinc and calcium were from FAO/WHO (FAO & WHO, 2004).

The weighed food record was done by trained female data collectors staying in the participant’s home from early morning (before the child had his/her first meal) until evening when the child ate his/her last meal for the day. Each data collector was provided with a digital food weighing scale (2 kg maximum weight: Model CS 2000, Oahu's Corporation, USA). The data collectors were trained to collect detailed information on type, quantity and preparation method of each food consumed, including recipe data. However, no recipe data were collected in our case as diets were simple and monotonous (such as sorghum/maize bread with boiled kale).

To determine intakes of the selected nutrients, a local food composition table was compiled using the Ethiopian Food Composition Tables (EFCT) Part III (EHNRI, 1998a) and IV (EHNRI, 1998b) and USDA (USDA Agricultural Research Service, 2014) Food Composition Tables. Samples were collected for some local foods (mostly breads made from various cereal staples) for which there were no nutrient values in the EFCT. A small amount of each of these food samples were collected from 3-5 households in a clean plastic Ziploc bags that were previously unused. Then the samples were immediately transported to *Hawassa* University Food Science Laboratory (Ethiopia) for hot-air oven-drying (within 1-2 hours of sample collection). Samples of the same food item were dried, mixed and stored together in a clean Ziploc plastic bag to create composite sample. Losses in the weight of cooked food samples ('as eaten') were calculated as moisture. Dried food samples were then analysed at the University of Saskatchewan (Canada). Any remaining moisture content was analysed using air-oven following AACC International Method 44-15.02; protein was analysed by using LECO's TruMac N (an equipment that measures protein/nitrogen in food by combustion) following AACC International Method 46-30.01. The inorganic constituents (iron, zinc and calcium) were analysed using flame Atomic Absorption Spectrophotometry according to AACC International Method 40-70.01.

Anthropometry: Various body measurements were collected from the children. The measurements included weight, via an electronic scale (Seca 770, Seca Corpo- ration, Hanover, MD, USA), recumbent length, via adult/infant length/stature measuring board (Perspective Enterprises, Portage, MI, USA), head circumference, via a flexible non-stretch tape, mid-upper arm circumference (MUAC), via colored MUAC insertion tape for children, and triceps skinfold thickness, via a skinfold caliper (*Holtain* Ltd, Crymych, United Kingdom), using standardized procedures (Gibson, 2005b). All children wore light clothing when measured for height/length and weight. Measurements were conducted at the local Health Centre, Health Post or community school compound, depending on physical proximity for participating households in each community. All measurements were taken in duplicates and a third measurement was taken whenever the difference between the first two measurements exceeded allowable limits (weight

100 g; circumferences 5mm; length/height 5 mm; skinfolds 2 mm). Date of birth for each child was determined from immunization card and/or local events calendar.

Data quality and analysis: Data quality was ensured by multiple means: we recruited data collectors who were fluent in the local languages and had at least some post-secondary training in nursing or related field; we provided three days of training on the questionnaire and weighed food record data collection in the meeting-rooms of local health offices; field level data collection was supervised by GE and nutrition BSc. graduate research assistants and completed questionnaires and forms were checked each night and concerns were addressed at the field setting; to minimize measurer errors, one anthropometrist (GE), with the help of research assistants, conducted all body measurements. All questionnaire based data were entered into SPSS (IBM SPSS Statistics, Version 20) and cleaned by running simple frequency distributions.

A univariate and bivariate analysis were carried out and data were presented using descriptive statistics (mean, standard deviations, median with first and third quartiles, percentages). The IYCF indicator variables were analysed based on the WHO guidelines (WHO, 2008). Based on the data gathered, we were able to calculate seven of the eight core, and two optional, IYCF indicators[13] as well as related feeding practice indicators (i.e., 'the giving of colostrum', 'pre-lacteal feeding' and 'frequency of breastfeeding in previous 24 hours') for breastfed children aged 0-23.9 months. The dietary diversity data were used to calculate median DDS (first, third quartile). In addition, proportions of children consuming from 0-2, 3-4, or 5-7 food groups were calculated using the 24-hours diet diversity data. These were classified as low, medium and high DDS, respectively according to Arimond & Ruel (Arimond & Ruel, 2004). Data from the 1-day weighed food records were used to calculate median (first, third quartile) values of energy, protein, zinc, iron and calcium which then were compared to estimated needs from complementary foods, as described earlier. Nutrient densities were also calculated by expressing the median intakes per 100 kcal of energy; these were also compared with desired levels based on estimated needs. The WHO Anthro (ver. 3.2.2) 2011 program was used to analyse all anthropometric data. Extreme values flagged by the software were checked and corrected at the field setting. Mean length-for-age z-score (LAZ), weight-for-length z-score (WLZ), weight-for-age z-score (WAZ), MUAC-for-age z-score, head circumference-for-age z-score, triceps skinfold thickness-for-age z-score (only for children ≥3 months) and BMI-for-age z-score were calculated for each of the two age groups and all age group children. Prevalence of stunting (LAZ <-2

[13] Definitions of indicators are provided as footnotes to the result tables 2a & 2b for quick reference;

Standard Deviation), wasting (WAZ <-2 Standard Deviation) and underweight (WAZ <-2 Standard Deviation) were also calculated for each age group. Results on anthropometric indices, DDS, median intakes of energy and the selected nutrients were disaggregated into 2 to 4 age categories [0-5 months, 6-8 months, 9-11 months and 12-23 months (or 6-23.9 months)] in agreement with the different IYCF feeding recommendations by WHO for these age groups. Independent *t*-test, Mann Whitney *U*-test (to test differences between groups) and *Chi*-square test (for categorical variables), were the statistical tests used, with significance set at a $p < 0.05$.

Ethical approval process and informed consent: Ethical approval was obtained from the University of Saskatchewan Behavioural Ethics Board, in Canada. In addition, a local ethics clearance was also obtained from the Regional Health Bureaus of the SNNPR and Regional State of Oromiya, Ethiopia. Permission was also obtained from local health offices from the respective districts and participating mothers for the conduct of the study. Mothers gave oral consent to participate in the study after a local female data collector explained the purpose of the study and everything it involved.

5.3. Results

A few of the participating mothers did not bring their children to the anthropometric assessment days or were not present at home during house visits, hence anthropometric results include 333 participants (87%). Findings on WHO core and optional feeding indicators have variable sample sizes due to the specific age range each indicator required. Results on background characteristics and IYCF practices were disaggregated across the *Halaba* and *Zeway* communities.

5.3.1. Participant and household characteristics

Background characteristics of participants are shown in Table 5.1. Most mothers in both sites were lactating and 27 years of age in average. Almost all mothers were married and Islam is the dominant religion in both locations, particularly in Halaba. Family sizes were generally high. Close to half or more households reported having ≥2 children under the age of five years and the difference was significant between communities ($p < 0.05$). One in four households in *Halaba* and one in six in *Zeway* practiced polygamy (result not shown). Majority of households in either community reported ownership of <1hectare cultivable land. Farming was the main occupation of the men and mothers were generally housewives with very minimal or no formal schooling. However higher proportion of men from the Zeway community reportedly received formal education ($p < 0.001$).

Table 5.1 Characteristics of study participants (i.e., mothers and family) from Halaba and Zeway, Ethiopia (n=383)

Background characteristics	Halaba (n=287)	Zeway (n=96)
Maternal age, *Mean (± SD)*	27.5 (5.4)	27 (6.4)
Household size, *Mean (±SD)*	5.9 (1.9)	6 (2.1)
Number of under 5y old child/family (%)		
One	52.3**	39.6
Two or more	47.7**	60.4
Religion (%)		
Muslim	97.6	67.7
Orthodox Christian	0.3	25.0
Protestant Christian	2.1	7.3
Marital status (%)		
Married	99	100
[1]Other	1	0
Mothers physiological status (%)		
Pregnant	5.2	2.1
Lactating	92.3	88.5
[2]Others	2.5	9.4
Mothers formal education (%)		
No formal education	79.4	62.5
Primary	16.3	28.1
Post primary	4.3	9.4
Husbands' formal education (%)		
No formal education	51.6***	15.6
Primary	31.4***	47.9
Post primary	17.0***	36.5
Husband's occupation		
Farmer	87.8	89.5
[3]Other	12.2	10.5
Mothers' usual occupation		
Housewife	93.7	88.5
Petty trading (small scale business)	3.5	5.2
[3]Other	2.8	6.3
HH cultivated land size ownership[4]		
≤ one hectare	73	67.8
> one hectare	27	32.2

HH= Households; [1]divorced, widowed, separated; [2]pregnant or lactating or non-pregnant and non-lactating; [3]civil servant, agricultural laborer, tenant farmer and daily laborer; [4] the sample sizes for this variable are 278 and 90 in *Halaba* and *Zeway*, respectively; **, ***significant at $p < 0.01$, $p < 0.001$ respectively;

5.3.2. Results on IYCF indicators

Table 5.2 summarizes some background characteristics and findings on breastfeeding practices of children aged 0-23.9 months. The proportion of male/female children was comparable in both communities. Birth weight for majority of children was not known. Almost all children were reported to have been breastfed at least once in the 24 months preceding the interview. Also most mothers reported giving colostrum to their babies. Timely initiation of breastfeeding was significantly lower in *Halaba* (63%) compared with Zeway (92%) children ($p < 0.001$). High rates

Table 5.2 Characteristics for children (0-23.9 months) and breastfeeding indicators from Halaba and Zeway, Ethiopia, 2013 (n=383)

	Halaba	Zeway
Sex of child (%)	n=287	n=96
Female	49.5	60.4
Male	50.5	39.6
Age in months, *mean (± SD)*	10.6 (6.9)	12.8 (6.2)
Child whose birth weight taken at delivery (%)	n=286	n=96
Yes	9.1	13.5
No	90.9	86.5
[1]Child ever breastfed (%)	n=267	n=93
Yes	98.5	100
[2]Early initiation of BF	n=268	n=90
Immediately (within 1 hour)	62.7***	92.3
After 1 hour	36.6***	4.5
Do not know	0.7	2.2
Giving of Colostrum[3] (%)	n=265	n=91
Given to baby	93.6	96.7
Discarded	6.4	3.3
Child given prelacteal[4] feed (%)	n=267	n=92
Yes	3.4	7.6
No	96.6	92.4
[5]Exclusive BF for infants (0-5) months (%)	n=87	n=15
Yes	86.2	93.3
No	13.8	6.7

BF= Breastfeeding; [1]Proporiton of children born in the last 24 months who were ever breastfed; [2]Proportion of children who were put to breast within one hour of birth; [3]First milk (thick yellowish milk the mother produces for the first few days after birth); [4]Any fluid/drink other than breast milk given to infants in first 3 days after birth; [5]feeding of breast milk only for children between 0-5 months of age (<183days)—calculated as proportion of infants 0-5 months who received only breast milk during the previous day; ***Significant at $p < 0.001$.

of exclusive breastfeeding (EBF) were also reported in both communities. Table 5.3 shows additional IYCF indicators: Continued breastfeeding was common at one year than two years of age. Most children were still being breastfed at the time of the study and majority were breastfed

Table 5.3 Infant and young child feeding indicators (%) for children (0-23.9 months) from Halaba and Zeway, Ethiopia, 2013 (n=279)

	Halaba	***Zeway***
[1]Continued BF at 1 y	n=41	n=12
Yes	92.7	100
No	7.3	0
[2]Continued BF at 2 y	n=19	n=14
Yes	68.4	78.6
No	31.6	21.4
Currently on BF by age (in months)		
0-5 (n_{Halaba} =84, n_{Zeway}=13)	95.2	100
6-11 (n_{Halaba} =75, n_{Zeway} =27)	97.3	92.6
12-23 (n_{Halaba} =109, n_{Zeway} =51)	85.3	86.3
Total (n_{Halaba}=268, n_{Zeway}=91)	91.8	90.1
Frequency of BF in previous 24h	n=236	n= 71
< 8 times	7.2	21.1
≥ 8 times	92.8**	78.9
[3]Introduction of solid, semi-solid or soft food	n=31	n=9
Yes	58.1	44.4
No	41.9	55.6
[4]Minimum meal frequency for BF children (6-23 months)	n=144	n =57
Yes	58.3	57.9
No	41.7	42.1
[5]Minimum diet diversity for (6-23 months)	n=198	n=81
Yes	8.1	8.6
No	91.9	91.4
[6]Minimum acceptable diet (6-23 months)	n=163	n=67
Yes	5.5	9
No	94.5	91

BF= Breastfeeding;
[1]Proporiton of children 12-15 months of age who were fed breast milk on the previous day;
[2]Proportion of children 20-23 months of age who were fed breast milk on the previous day;
[3] Proportion of infants 6-8 months of age who received solid, semi-solid or soft foods during the previous day; [4]Propotion of breastfed children (6-23months) who received solid, semi-solid or soft foods the minimum number of times or more during the previous day (minimum: 2 times for children 6-8 months and 3 times for children 9-23 months); [5]Proportion of children 6-23 months of age who received from 4 or more food groups (of the 7) during the previous day;
[6]proportion of children 6-23 months of age who had at least the minimum meal frequency and diet diversity on the previous day; significant at $p < 0.01$;

the minimum number of times (≥8) in the day and night preceding the interview—differences were significant between the communities ($p < 0.01$).

Timely introduction of complementary food showed 58% and 44% prevalence in *Halaba* and *Zeway* children, respectively. Proportion of breastfeeding children 6-23.9 months who were getting solid or semi-solid foods with minimum meal frequency were 58% in both locations. Only about 8-9% of these children received a complementary food that met WHO's minimum dietary diversity of ≥4 food groups. Overwhelming majority did not get the minimum acceptable diet in either community.

5.3.3. Anthropometric outcomes

Table 5.4 summarizes nutrition assessment based on anthropometric measurements only for children <24 months of age**.** Mean length-for-age z-score (LAZ) was negative, significantly lower for Halaba than Zeway and worse in the older age group. Children 6-23.9 months scored significantly lower mean z-scores for weight-for-age (-1.5 in *Halaba* and -1 in *Zeway*, $p < 0.01$) and negative scores for most other indicators except head circumference-for-age.

Overall prevalence of stunting in children <2yrs of age was high or very high in either of the study community, particularly in Halaba and in the complementary feeding than the exclusive breastfeeding age group. Overall underweight rate was also significantly higher in Halaba than Zeway children ($p < 0.05$). Also both stunting and underweight were significantly higher ($p < 0.05$ and $p < 0.01$, respectively) in 6-23.9 months of age children in Halaba than Zeway.

5.3.4. Dietary diversity

The overall median DDS **(**Table 5.5**)** for all children was 2 and the lowest median DDS was for 6-8 months of age children in both *Halaba* and *Zeway*. In either community, majority of the children fell under the 'low' DDS class (i.e., consumed only 0-2 food groups) and the proportions were highest in the younger children. Differences were not significant between study communities except in 6-8 months' group where 38.5% of Zeway children consumed from 3-4 food groups compared to 11% in Halaba ($p < 0.05$); also proportions in low DDS class were lower in Zeway compared with Halaba ($p < 0.05$).

Figure 5.2 shows which specific food groups, by age group of children, were commonly used for complementary foods in the study communities. Accordingly, food groups consumed by more than 50% of the children in each age group, in both *Halaba* and *Zeway* areas, were *'grains,*

Table 5.4 Anthropometric measurements [mean (±SD)] and prevalence of stunting, wasting and underweight by age groups for children under two years of age from Halaba and Zeway, Ethiopia, 2013 (n=333)

	Age 0-5 months		Age 6-24 months		All children	
	Halaba	*Zeway*	*Halaba*	*Zeway*	*Halaba*	*Zeway*
Z-scores	n = 76	n = 9	n = 181	n = 67	n = 257	n = 76
Length-for-age	-0.9 (1.3)	-0.4 (1.1)	-2 (1.4) ***	-1.2 (1.7)	-1.7 (1.5) **	-1.1 (1.7)
Weight-for-length	0.2 (1.3)	0 (1.4)	-0.6 (1.2)	-0.5 (0.9)	-0.4 (1.3)	-0.4 (1)
Weight-for-age	-0.6 (1.4)	-0.3 (1.3)	-1.5 (1.3) **	-1 (1.1)	-1.3 (1.4)	-1 (1.2)
BMI-for-age	-0.2 (1.4)	-0.1 (1.4)	-0.4 (1.3)	-0.3 (0.9)	-0.3 (1.3)	-0.3 (1)
	n = 75	n = 9	n = 180	n = 67	n = 255	n = 76
HC-for-age	0.6 (1.3)	0.1 (0.9)	-0.1 (1.1)	0.2 (1.2)	0.1 (1.2)	0.2 (1.1)
	n = 32	n = 6	n = 181	n = 67	n = 213	n = 73
[a] MUAC-for-age	-0.8 (1)	-1.2 (1.2)	-1.4 (1.1)	-1.5 (0.9)	-1.3 (1.1)	-1.5 (1)
	n = 31	n = 6	n = 171	n = 65	n = 202	n = 71
[a] Triceps skinfold-for-age	-0.3 (1)	-0.4 (1.2)	0 (1) *	-0.3 (0.8)	-0.02 (1) *	-0.3 (0.9)
Prevalence estimates (%)	n = 76	n = 9	n = 181	n = ~67	n = 257	n = ~76
[b] Stunting (LAZ <-2SD)	17 (22)	1 (11)	98 (54) *	24 (36)	115 (45)	25 (33)
Wasting (WLZ <-2SD)	5 (7)	1(11)	18 (10)	4 (6)	23 (9)	5 (7)
[c] Underweight (WAZ < -2SD)	10 (13)	2 (22)	61 (34) **	9 (14)	71 (28) *	11 (15)

[a] Three months was the lowest age used for this indices; [b] Significant by age group (χ^2= 21.9, $p < 0.001$) for *Halaba* children; [c] significant by age group (χ^2=11.3, $p < 0.001$) for *Halaba* children; *significant at $p < 0.05$; ** $p < 0.01$, *** $p < 0.001$ between communities (independent *t*-test for means and Mann Whitney *U*-test for proportions); BMI=Body mass index; MUAC=Mid-upper arm circumference; TSF=Triceps skinfold thickness; LAZ=Length-for-age z-score; WLZ=Weight-for-length z-score; WAZ= Weight-for-age z-score; SD=Standard deviation; HC=Head circumference

Table 5.5 Dietary diversity scores (DDS [a]), and proportions of Halaba and Zeway children in different DDS classes, Ethiopia, 2013 (n=278)

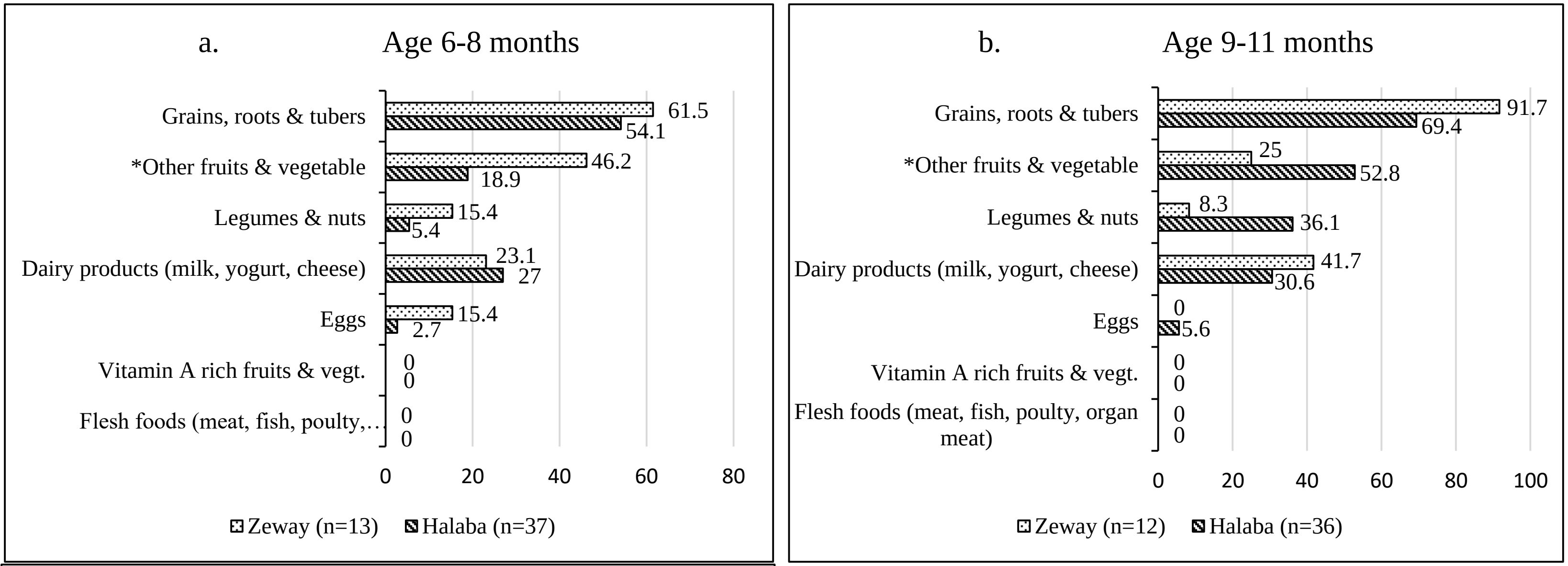
DDS	Age 6-8 months	Age 9-11 months	Age 12-24 months	All children
Halaba	n=37	n=36	n=125	n=198
Median (25th, 75th percentile)	1 (0, 2)	2 (0.25, 3)	2 (2, 3)	2 (1, 3)
Frequencies (%) consuming				
0-2 food groups (Low)	33 (89.2) *	21 (58.3)	73 (58.9)	127 (64.5)
3-4 food groups (Medium)	4 (10.8) *	14 (38.9)	50 (40.3)	68 (34.5)
5-7 food groups (High)	0 (0)	1 (2.8)	1 (0.8)	2 (1.5)
Zeway	n=13	n=12	n=56	n=81
Median (25th, 75th percentile)	1 (0, 3)	2 (1, 2)	2 (2, 3)	2 (2, 3)
Proportions (%) that consumed				
0-2 food groups (Low)	8 (61.5)	11 (91.7)	30 (53.6)	49 (60.5)
3-4 food groups (Medium)	5 (38.5)	1 (8.3)	24 (42.9)	30 (37)
5-7 food groups (High)	0 (0)	0 (0)	2 (3.6)	2 (2.5)

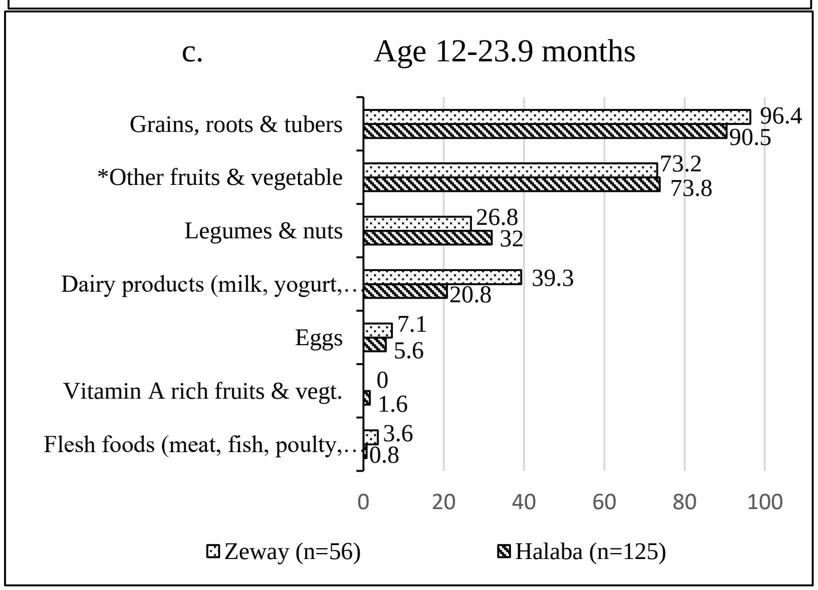
[a] DDS ranging between 0-2, 3-4, and 5-7 are considered of low, medium and high diet diversity, respectively, based on the WHO seven main food groups (Arimond & Ruel, 2004; WHO, 2008). *Significant between communities at $p < 0.05$ (based on *Fisher exact test*)

roots and tubers' and *'other fruits and vegetables'*. Foods from *'legumes and nuts'* and *'dairy products'* were consumed by nearly a quarter of children in both locations, except dairy products were consumed by significantly higher (37%) proportion of *Zeway* than *Halaba* (24%) children ($p <$ 0.02). Consumption from *'flesh foods'* and *'vitamin-A rich fruits and vegetables'* were very minimal or none-existent.

5.3.5. Dietary intakes of energy and selected nutrients from complementary foods

Table 5.6 summarizes median (first, third quartiles) intakes of energy and selected nutrients with associated nutrient density across age groups and compared with 'estimated needs' for breastfeeding children. In both communities, median values of protein were generally higher compared with estimated needs for each age group. Median intakes of energy and iron, zinc and calcium, and associated nutrient densities in both communities were lower than the expected 'estimated needs' from complementary foods—the exception was iron in the age group 12-13 months which was higher than estimated needs. However, parametric and nonparametric independent sample tests did not show significant differences in intakes between communities within each age category.





*The food consumed in this group is mostly Ethiopian kale which is usually boiled and seasoned with salt, onion, oil and pepper for consumption with starchy staples (grains, roots and tubers)

Figure 5.2 Proportions (%) of children by age group (a, b & c) consuming specific food groups based on single 24 h recalls, in rural Halaba and Zeway, Ethiopia

Table 5.6 Median (first, third quartile) energy and selected nutrient intakes and nutrient density from complementary foods compared with estimated needs* of Halaba and Zeway children based on age, Ethiopia (2013)

	Age 6-8 month		Age 9-11 months		Age 12-23 months	
	Halaba (n=12)	*Zeway* (n=5)	*Halaba* (n=17)	*Zeway* (n=4)	*Halaba* (n=59)	*Zeway* (n=23)
Energy (Kcal)	163 (139, 222)	119 (83, 367)	251 (137, 403)	196 (43, 410)	334 (196, 580)	472 (295, 604)
Estimated need		202		307		548
Estimated need [a]	118 (78, 141)	111 (80, 261)	213 (154, 270)	222 (185, 270)	345 (292, 450)	398 (365, 434)
Protein (g)	5.4 (3.9, 7.9)	7.4 (3.4, 8.3)	8.7 (5.8, 15.6)	6 (1, 14)	13.4 (8, 24)	12.3 (7.6, 18.6)
Estimated need		2		3.1		5
Iron (mg)	6.1 (2.6, 13.3)	4 (3, 8)	7.4 (4.6, 15.2)	5.5 (0.5, 14.3)	12.8 (8.3, 26.1)	13 (6.8, 18.8)
Estimated need		18.4 (L), 9.1 (M)		18.4 (L), 9.1 (M)		11.4 (L), 5.8 (M)
Zinc (mg)	1.4 (0.9, 2.1)	2 (1, 1.6)	2 (1.4, 3.7)	3.6 (0.2, 3.4)	3.1 (1.8, 4.9)	3 (2, 4)
Estimated need		7.6 (L), 3.3 (M)		7.7 (L), 3.4 (M)		7.6 (L), 3.7 (M)
Calcium (mg)	112 (60, 151)	31 (23, 193)	164 (93, 301)	72 (1.5, 158)	222 (125, 364)	143 (78, 273)
Estimated need		211		228		346
Nutrient Density (per 100 kcal)						
Protein density (g/100 kcal)	3.3 (2.4, 4.8)	6.2 (2.9, 7)	3.5 (2.3, 6.2)	3 (0.5, 7.1)	4 (2.4, 7.2)	2.6 (1.6, 3.9)
Desired		1		1		0.9
Iron density (mg/100 kcal)	3.7 (1.6, 8.2)	3.4 (2.5, 6.7)	2.9 (1.8, 6)	2.8 (0.3, 7.3)	3.8 (2.5, 7.8)	2.8 (1.4, 4)
Desired		9.1 (L), 4.5 (M)		6 (L), 3 (M)		2.1 (L), 1.1 (M)
Zinc density (mg/100 kcal)	0.9 (0.6, 1.3)	1.7 (0.8, 1.3)	0.8 (0.6, 1.5)	1.8 (0.1, 1.7)	0.9 (0.5, 1.5)	0.6 (0.4, 0.8)
Desired		3.8 (L), 1.6 (M)		2.5 (L), 1.1 (M)		1.4 (L), 0.7 (M)
Calcium density (mg/100 kcal)	69 (37, 93)	26 (19.3, 162)	65 (37, 120)	37 (0.8, 81)	66 (37, 109)	30 (17, 58)
Desired		104		74.3		63

Median (25th, 75th percentile) *Sources of estimated needs from complementary foods: energy from 2004 FAO/WHO/UNU report (Dewey & Brown, 2003; FAO, 2004), protein from 1998 WHO report (WHO, 1998); micronutrients from 2004 FAO/WHO report (FAO & WHO, 2004); [a] estimated energy need adjusted for size of the study children by multiplying the need/kg/day by median weight for each age group; L=Low bioavailability; M= Moderate bioavailability;

Our attempt to explore possible associations of stunting with background characteristics and feeding practices using logistic regression analysis did not show any significant association, with the exception of child age, both in bivariate and multiple regression analysis (result not shown).

5.4. Discussion

We found that several of the IYCF practices in these communities were suboptimal falling short of many of the WHO recommendations(WHO, 2008; WHO & UNICEF, 2003). Overall rates of stunting (45%) and underweight (28%) we found among Halaba children <2y of age are levels WHO classifies as "very high" and "high" public health concerns, respectively (WHO, 2010, 2015). We also found high (33%) stunting prevalence among children from *Zeway* area. These unacceptably high levels of child undernutrition we reported here may have been in part due to the suboptimal feeding practices prevalent in the study areas. However, high levels of undernutrition among under two years of age children were also reported in past DHS (CSA & ICF International, 2012; CSA and ORC Macro, 2001; CSA and ORC Marco, 2006) and other IYCF studies conducted elsewhere in the SNNPR (9, 10).

Similar to the national and regional trends (CSA & ICF International, 2012) breastfeeding was a widely accepted practice as nearly all our study children (0-23.9 months) were breastfed at some point in their lives. The high affirmative responses in both communities on giving 'colostrum' to infants are encouraging as colostrum is nutritious and contains antibodies which help protect newborns from infection (UNICEF et al., 2010). Better mean z-score values were recorded for infants in the younger age group (0-5 months) which perhaps supports the fact that children do better during the exclusive breastfeeding period. Growth faltering is more pronounced starting six months of age. This is also the time complementary foods are introduced to meet increased nutrient-energy demands of growing children but often fail to be adequate compared to the completeness of breast milk.

Significant proportion (37%) of mothers in *Halaba* did not timely initiate breastfeeding. A comparable proportion (33%) of mothers in SNNPR also did not timely initiate breastfeeding, according to DHS 2011 (CSA & ICF International, 2012). Unlike the Halaba mothers in our study, another study in the adjacent district (Tessema et al., 2013) reported 94% timely initiation of breastfeeding. However, similar to our finding, a breastfeeding study from Jimma area (southwest Ethiopia) (Tamiru et al., 2012) also reported 63% rate for timely initiation of breastfeeding, hence our finding for *Halaba* was not a unique scenario. The high rates of EBF among infants 0-5 months reported here should be interpreted with caution due to the small sample and the indicator's tendency to overestimate the outcome because it only considers current EBF status in infants (WHO, 2008). Continuing breastfeeding up to 24 months or beyond is among key IYCF recommendation by WHO. We noticed larger drops in continued breastfeeding practices, going from year one to year two, (25% in *Halaba* and 21% in *Zeway*, Table 5.3) compared with only 14% drop reported in the 2011 DHS (CSA & ICF International, 2012), indicating the need to educate adherence to IYCF guidelines in our communities.

Introduction of complementary feeing at 6 months for breastfeeding children is vital to support the rapid growth at this stage. The study by Tessema et al. (Tessema et al., 2013) showed that both early (before six months) and late (after six months) introductions of complementary foods to infants from Sidama communities were associated with higher likelihood of being stunted. Similar IYCF and child feeding studies in Guatemala, India and Nepal (Meshram et al., 2013; Paudel, Pradhan, Wagle, Pahari, & Onta, 2012; Reurings, Vossenaar, Doak, & Solomons, 2013) have documented association of suboptimal feeding practices, among other factors, with poorer child nutritional outcome—particularly with stunting. The study by Gibson et al. (Gibson et al., 2009) elsewhere in SNNPR also showed impaired growth among children was associated with inadequate feeding practices. In our study, proportion of children aged 6-8 months in *Halaba* and *Zeway* fed with solid, semi-solid or soft foods were 58% and 44%, respectively, implying the need to strengthen nutrition education programs in these communities. However, duet to the narrow age range (6-8 months) of the indictor, only a small number of children were used for calculating this indicator and, as such the result should be interpreted with care.

WHO also recommends that breastfeeding children aged 6-8 months and 9-23 months should be fed solid, semi-solid or soft foods at least twice and three times a day, respectively, with minimum diet diversity (i.e., consumption from at least four food group) (WHO, 2008). In our study children, significant proportions (42%) were not getting the minimum meal frequency, and much more (92%) the minimum dietary diversity in either community.

Our supportive findings (Table 5.5) also showed a median DDS of just two in both communities with highest proportions of the children being under 'low DDS' group, according to Arimond and Ruel's classification (Arimond & Ruel, 2004). Children aged 6-8 months were worse, having the lowest median DDS and classed in the 'low DDS' group, compared with older children. ‘Grains, roots & tubers’ and ‘other fruits & vegetables’ were the food groups most relied up on (Figure 5.2) with minimal consumptions from other groups, especially of animal origin. This meant very few (5% in *Halaba* and 9% in *Zeway*) of our study children received the minimum acceptable diet, not much different from what were reported at regional (2.3%) and national (4%) levels in the 2011 DHS or earlier IYCF studies by Gibson et al. (WHO, 2008) and Tessema et al. (Tessema et al., 2013). We think the situation is very concerning in light of the country’s health extension program and the supportive IYCF work done by the Alive & Thrive phase-1 project (Alive & Thrive, 2014) in the 5-6 years prior to our study. Re-examining or strengthening existing nutrition education programs or the delivery strategies in our and similar communities may be of benefit.

Finally the one-day weighed food record analysis from a sub-sample (Table 5.6) showed that median protein intakes from complementary foods in either location were more than twice the recommendation by WHO (WHO, 1998). Gibson et al (11) also documented median protein intakes that were above estimated needs across the age groups of 6-8, 9-11 and 12-23.9 months. This might indicate protein intakes from complementary foods may not be of concern for breastfeeding children in these communities. However, parallel to Gibson et al (11) findings and assuming low bioavailability, median intakes of iron, zinc and calcium in either of our study community, except iron for children in the older age group, were a quarter or less (in Halaba) and less than half (in Zeway) of estimated needs. Deficiencies of these micronutrients, particularly zinc, are known to affect linear growth in children.

Unless diet qualities are improved, efforts to reduce the high prevalence of stunting in these areas may be challenged. The following could be some practical ways the diets of infants and young children could be improved in these two settings: Zeway community could take advantage of ‘Lake Zeway’ to produce fruits and vegetables which, with proper nutrition/health education, can improve diet qualities of complementary feeding children. The Halaba communities could take advantage of the tradition of pulse agriculture, commonly produced for cash income, by retaining some of the produce for home consumption and/or using the proceeds generated from pulse sales to procure other nutritious foods (including fruits, vegetables and animal source foods) for home consumption. Consumptions of animal source foods (flesh foods & egg) as well as vitamin A rich fruits and vegetables were very minimal at both locations hence, promotion of consumption from these food groups when possible should be encouraged. We also recommend strengthening the education of parents/caregivers on both complementary and optimal breastfeeding practices of children as part of the health extension package or through scaling up the work of Alive & Thrive.

The strength of this study was supplementing the self-reported IYCF practices—which may have been influenced by the behaviour change communication messages from Alive & Thrive project or the country's health extension program-with estimates of dietary intakes and anthropometric assessment. Given the implementation of national nutrition program since 2008, our findings can provide important feedback on IYCF practices to nutrition programs in the region. However, the observational nature of the study limits us from establishing cause and effect relationships. No repeated 24 h dietary diversity recalls or weighed food record data were taken; therefore, values we reported do not represent usual intakes of individual children, nor do they account for seasonal variations. Limited by the objective of the larger study to which the current study was a part, we had data only for analysis of energy, protein and three minerals, and were unable to analyse vitamin A and other micronutrients. The lack of meaningful association with other variables than child age may have been due to the limited variability in background characteristics and feeding practices and/or due to our small sample size. We believe repeating the study in different seasons, including analysis of all problem-nutrients, may provide a more complete picture of IYCF practices in the areas without the confounding effect of seasonal variations.

5.5. Conclusion

Overall, this community-based study showed low diversity in the diet of infants and young children where majority of them (60-65 %) consumed from 0-2 food groups. Many of the core and optional IYCF practices were suboptimal. Median intakes of selected micronutrients (zinc, iron and calcium) from complementary foods were below estimated needs. We also reported unacceptably high levels of stunting and medium to high levels of underweight among the children. The observed very high levels of child stunting and suboptimal infant and young child feeding practices, as well as the low DDS and median intakes of nutrients from complementary foods, indicate a need to improve and strengthen nutrition service delivery for complementary-feeding children in rural communities of *Halaba* and *Zeway* areas, Ethiopia. We believe the findings and the recommendation are generalizable to other similar rural communities in the respective regions.

Chapter 6 Household Food Insecurity and Hunger in Selected Ethiopian Agricultural Communities: Examination of Supply and Demand Factors (Study 3)

Abstract

Food insecurity and hunger are major challenges in many Ethiopian communities with repercussions on health and nutrition outcomes in vulnerable household members. Depending on the context, a combination of supply and demand as well as community or institutional factors may affect household food insecurity and hunger. The objective was to determine the degree of household food insecurity and hunger, and examine the contribution of associated contextual factors, in two rural communities of Ethiopia, namely Halaba and Zeway, located in two adjacent regions of the country (SNNPR and Oromiya Regions, respectively). A sample of 630 households were randomly selected from the two districts, and levels of food insecurity and hunger were measured using the Household Food Insecurity Access Scale and Household Hunger Scale developed by Food and Nutrition Technical Assistant project (United States Agency for International Development). Multiple classification analysis was employed to explore the effects of key demand (e.g. household size, livestock) and supply (e.g. land size, wealth) factors as well as community (geographic location) and institutional (participation in food security programs) factors on food insecurity and hunger. Household food insecurity was unacceptably high in both districts (95% in Halaba & 67% in Zeway). Household hunger was 38% in Halaba and 18% in Zeway. Both food insecurity and hunger were significantly greater in Halaba ($p < 0.001$), indicating an effect of geographic location. Both supply and demand factors were significant in determining household food insecurity and hunger ($p < 0.01$); however, supply factors such as women's access to land, land size and wealth had greater influence than the demand factors. Levels of food insecurity and hunger in both communities were very high and of serious concern. The study recommends increasing the food supply, and its subsequent accessibility, for households through enhancing women's access to land, improving income through savings and wealth accumulation, introducing more inclusive programs for women's participation and reducing household work-burden by significantly enhancing productivity of cultivable land

K**eywords:** Household food insecurity, household hunger, demand-supply factors, Ethiopia

6.1. Introduction

Food security is complex as it is multidimensional. As such the definitions of food security have evolved through the decades from a national level food supply emphasis to household level food access and individual level utilization (Smith, Pointing, & Maxwell, 1992). One definition adopted by the 1996 World Food Summit states “food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life” (FAO, 1996). Based on this definition, the partial or complete absence of these conditions at household level may lead to household food insecurity or even household hunger, in severe situations.

Ethiopia is among the many sub-Saharan African and other low-income countries experiencing household food insecurity and hunger at various times during the year (Ali et al., 2013; Deitchler, Ballard, Swindale, & Coates, 2010; Endale, Mengesha, Atinafu, & Adane, 2014; Regassa, 2011; Regassa & Stoecker, 2012b). The vulnerability to food insecurity in Ethiopia is exacerbated, in part, by its heavy dependence on small scale, mostly low-input, rain-fed agriculture (Devereux, 2000) which supports the livelihood of over 85% of the population (CSA, 2015b). Several studies in different parts of Ethiopia have reported on the prevalence of household food insecurity and its negative nutritional consequences on vulnerable household members (Ali et al., 2013; Anderson, Tegegn, Tessema, Galea, & Hadley, 2012; Belachew, Lindstrom, Gebremariam, et al., 2013; Belachew et al., 2012; Belachew, Lindstrom, Hadley, et al., 2013; Hadley, Tessema, & Muluneh, 2012; Roba et al., 2015). Though food insecurity is generally considered a characteristic of the rural poor, high rates of food insecurity were also documented in urban settings (Birhane, Shiferaw, Hagos, & Mohindra, 2014; Kimani-Murage et al., 2014).

Often food insecurity is a socioeconomic condition in which households of low-socioeconomic status have limited economic access to sufficient and quality foods for all family members throughout the year. Previous household level studies documented factors such as household size, land size, educational status, headship, access to credit services, agricultural extension packages as key predictors of household food security status (Belachew et al., 2012; Birhane et al., 2014; Endale et al., 2014; Regassa, 2011; Sewnet, 2015). These and other similar factors such as women’s access to land, work burden on women, frequency of production per year and livestock ownership could be summarised as demand or supply side factors at household level. Demand side factors generally affect households’ ability to access adequate food while supply side factors mainly affect the food supply. Despite some attempts (Alem, 2013; Feleke, Kilmer, & Gladwin, 2005) evidence is limited whether household food insecurity is more a function of demand or supply side factors, or a combination of both, at the household level in rural Ethiopia.

While several tools may be available, the Food and Nutrition Technical Assistant project (FANTA) of the United States Agency for International Development (USAID) introduced a Household Hunger Scale (HHS) in 2011 as a method to measure a more severe form of food insecurity at household level (Deitchler et al., 2011). Unlike the commonly used Household Food Insecurity Access Scale (HFIAS), the HHS has been validated for cross-cultural use allowing comparison of findings across various regions within and between countries (Deitchler et al., 2010). Literature search did not locate studies that applied the HHS to estimate household hunger in rural Ethiopia, with the exception of two studies by Regassa (Regassa, 2011; Regassa & Stoecker, 2012b). These previous studies did not, however, assess whether food insecurity and hunger were a function of demand or supply side factors at household level.

Therefore, this study measured household food insecurity and hunger in the agricultural communities of Halaba and Zeway in Ethiopia, using both HFIAS and the new HHS, and determined whether demand-supply, or a combination of these factors, at household levels predicted vulnerability to household food insecurity and hunger. The decision to use both tools was to enable us compare results with previous studies that utilized the HFIAS and also the few studies that used the new HHS in similar settings. The study sites, selected on their farming practices, were part of a larger collaborative research project between Hawassa University (Ethiopia) and the University of Saskatchewan (Canada) that sought to improve food security and human nutrition through improving agricultural practices in these areas.

6.2. Methods

6.2.1. Study setting, participants and design

The study was conducted in three rural communities located in two adjacent administrative regions of Ethiopia. Two of the three communities (locally known as *Guba-Sherero* and *Holagoba-Kukie)* were part of the Halaba district, located in the Southern Nations and Nationalities and People's Region (SNNPR). Halaba district is located approximately 85 kilometers northwest of *Hawassa*, the capital of SNNPR. The district is known for growing pepper and pulses, both of which are considered cash crops for the farmers. Rain-fed agriculture is the main livelihood. The third rural community (locally known as *Edo-Qontola*) is located near the town of Zeway and is part of Adami-Tulu-Jido-Kombolcha district in the Oromiya Region. It is located approximately 160 kilometers southeast of Addis Ababa, Ethiopia's capital. Maize, teff, wheat, barley and different oil seeds are the major crops produced in the district. The area is mostly dry land, and agricultural use of the land is both irrigated and rain-fed.

A total of 630 households (413 from Halaba and 217 from Zeway communities) were selected to participate in this study using simple random sampling. Ten data collectors met at the central location of each community and randomly walked in different directions to individual households. Households were selected based on whether they had at least one <5y of age child (to enable us conduct other mother-child nutrition specific studies) until the sample size was achieved. Sample size was determined using formula for cross-sectional studies (Charan & Biswas, 2013), assuming the 27% probability of maternal undernutrition reported at national level (CSA & ICF International, 2012). The respondents were women (mothers) in the selected households as they were mostly responsible for the procurement, preparation and serving of meals, and hence were well informed about the food supply situation of the household. Data were collected between the months of March to June.

6.2.2. Data collection, tools and analysis

The women were interviewed by trained female data collectors who had some post-secondary education and spoke the local languages fluently. The data collection was supervised by an investigator (GE) and a research assistant who also spoke the local language fluently. Background characteristics of participating households were collected by a translated questionnaire adapted from previous national and local survey studies in the regions (EHNRI, 2010; Roba et al., 2015; Tessema et al., 2013). Information collected included household size, age of respondents, headship of households, size of cultivable land, women's access to land, person in charge of production (men or both men and women), frequency of cultivation of food crops per year, occupation of mothers and their husbands, information on livestock, various household assets, housing characteristics (types of floor, roof, window materials), sanitation facility, source of drinking water, persons mainly responsible for hauling water and the time required per trip, and household's involvement in any food security programs in their respective administrative districts.

These background characteristics were used directly or as proxy measures to generate various supply and demand related factors that may affect household food insecurity and hunger. Hauling water is mostly the responsibility of women which takes time away from other productive activities (e.g. working on farm, cash earning activities) and adds work burden since water sources are not available on premises (WHO & UNICEF, 2010). Hence, time required to fetch water (<30minutes/trip or ≥30 minutes/trip) was used as a proxy to measure presence of work burden on women (Bureau of Women Youth and Children Affairs, 2013; WHO & UNICEF, 2010). In this case, a single trip requiring half an hour or more was taken as indicator of presence of work burden. Physiological density (the ratio of number of persons in the household [that needs to be fed] to unit of cultivable land owned by the household) was also calculated and households were classified as above or below the average (≤8 or >8). Livestock information was used to calculate Tropical Livestock Units (TLU). One TLU is the equivalence of 250kg of livestock owned by the household (Storck et al., 1991) and households were grouped as having low (<2.5), medium (2.5-5) or high (>5) TLU, using values below the mean, within up to twice the mean, and above twice the mean, respectively.

Wealth index for each household was also generated using household assets (i.e., ownership of radio, television, mobile phone, bicycle, animal drawn cart, motorcycle, handheld torch, and oxen), housing characteristics (i.e., corrugated iron or thatched grass roof, cow dung smeared/cemented or earth/dirt floor, presence or absence of windows, crowding [persons per sleeping room > 5 or ≤ 5]) and access to improved sanitation. Scores 1 or 0 were assigned for each household based on ownership of each asset or housing characteristics or access to improved sanitation facility. Then households were grouped into three of wealth index as low (<4), medium (4-8) and high (>8), following similar procedure as the TLU groups.

Degree and prevalence of household food insecurity were assessed using a translated scale developed by the Food and Nutrition Technical Assistance (FANTA) project of United States Agency for International Development (USAID) for use in developing countries (Coates et al., 2007). The Household Food Insecurity Access Scale (HFIAS), version 3, is administered with a recall period of four weeks. Several food security studies in Ethiopia have used this tool (Belachew, Lindstrom, Gebremariam, et al., 2013; Birhane et al., 2014; Endalew, Muche, & Tadesse, 2015; Regassa & Stoecker, 2012b). It contains nine main items followed by frequency questions (i.e., *1. rarely, 2. sometimes, and 3. often*) completed for every affirmative response in the main item. If each household were to respond affirmatively to the nine items of HFIAS with a frequency of occurrence of *'3. often'*, then there would be a maximum possible score of 27 for each household that responded to all the nine items of the scale. A score closer to zero indicates absence of food insecurity and a score closer to 27 means greater degree of food insecurity.

The nine items in HFIAS are arranged to measure increasing severity of occurrence of the event, with the last three indicating severe conditions of household food insecurity. Utilizing the last three main items from HFIAS, FANTA also introduced a simple scale called Household Hunger Scale (HHS) (Deitchler et al., 2011). The HHS was intended to identify proportions of households at different levels of household hunger and was validated for cross-cultural comparison (Deitchler et al., 2011). The scores on HHS range from 0-6, with higher scores representing increasing severity of household hunger. Research by Regassa (Regassa and Stoecker 2012, Regassa 2011) has used this tool in similar Ethiopian communities. Therefore, HHS was also used to estimate prevalence of household hunger.

All questionnaires were inspected at field level. The data were entered into a SPSS spreadsheet (SPSS Statistics Version 20, IBM Corp., Armonk, NY, USA), previously prepared based on each item and response options on the questionnaire. Mean, standard deviation, median, percentile values (25th, 75th) and percentages were used to present findings from univariate and bivariate analysis. Results from HFIAS were presented as percent of households with affirmative responses to each of the nine main items and average degree of food insecurity and hunger in each community were expressed as median scores and percentile values (25th, 75th). Median scores were compared using Mann Whitney *U-test.* In addition, using the summary measures in HFIAS guide (Coates et al. 2007), households were grouped using summary measures of the scale as *food secure,* or *insecure (i.e., mildly* or *moderately* or *severely food insecure)*. Households were also classified as having *'little to no household hunger'* or *'moderate household hunger'* or *'sever household hunger'* based on HHS (Deitchler et al., 2011). Categorical variables were compared between communities using C*hi-square* test.

In the multiple variable analysis, a combination of selected demand (i.e., number of under 5y of age children/household, physiological density, household TLU, wealth index) and supply-side (women's access to land, work burden on women, household land size, frequency of crop production per year,) as well as community variable (being in Halaba or Zeway area, as proxy to the farming practices) and institutional variable (participation in any food security programs in the district) were used as explanatory factors. The selection of these factors was based on previous studies (Alem, 2013; Belachew et al., 2012; Birhane et al., 2014; Endale et al., 2014; Feleke et al., 2005; Regassa, 2011; Sewnet, 2015). Scores for degree of household food insecurity and household hunger in the pooled data from the two districts were used as dependent (outcome) variables in two separate models.

A Multiple Classification Analysis (MCA) was used to present the mean of the dependent variables across each level of the selected categorical predictor variables (Nagpaul, 1999). Both unadjusted and adjusted mean scores along with their associated Eta (η) and Beta (β) values were reported, respectively. *Eta* indicates the bivariate association between a predictor and the dependent variable whereas *beta* indicates the relationship of a predicator variable to the dependent variable in the multiple classification analysis model, keeping all other predictors constant (Nagpaul, 1999). *Beta* also signifies the relative importance of the variable in predicting variation in the dependent variable while the square of *Eta* signifies the amount of variation explained by all categories of the predictor. *F*-values are reported for each model with the degrees of freedom, the associated R^2 and *P*-values. A *P*-value of <0.05 was used to determine statistical significance.

This study was conducted according to the guidelines laid out in the Declaration of Helsinki and all procedures involving human subjects were approved by the University of Saskatchewan Behavioral Ethics Board (BEH #12-357) and the Regional Health Bureaus of SNNPR and Oromiya. Verbal informed consent was obtained from all subjects. Verbal consent was witnessed and formally recorded.

6.3. Results

6.3.1. Background characteristics

Most households completed all background questions. One household from Zeway community did not complete the food security assessment, hence the results were presented for a total of 629 households out of the 630 selected. The communities were similar on most background characteristics, such as ownership of livestock, toilet facility, person responsible for hauling water (Table 6.1). Significant differences were observed between the communities in the size of cultivable land, [14]Enset plant ownership, source of drinking water and time required to fetch water ($p < 0.001$). Additional background information has been provided in chapter 4 (Table 4.1).

Table 6.1 Individual and household related background characteristics of study participants from Halaba and Zeway rural districts, Ethiopia, 2013

Background characteristics	*Halaba*	*Zeway*	Combined	*P*-values*
HH cultivated land size (%)	n=396	n=199	n=595	
≤ 0.5 hectare	33.8	23.1	30.3	< 0.05
0.6-1.0 hectare	40.9	40.7	40.8	
>1.0 hectares	25.3	36.2	28.9	
Ownership of Enset (*E. ventricosum*) plant (%)	n=407	n=214	n=621	
Yes	8.8	1.4	6.1	< 0.001
HH ownership of domestic animals (%)	n=413	n=216	n=629	
Yes	84.7	82.4	83.9	
HH toilet facility (%)	n =413	n=217	n=630	
No toilet facility	26.6	35	29.5	
Traditional pit latrine	17.4	15.2	16.7	
Pit latrine with shade	55.8	49.3	53.5	
Ventilated improved pit latrine	0.2	0.5	0.3	
Source of drinking water (%)	n =413	n=217	n=630	
Public tab/stand pipe	95.9	47	82.3	< 0.001
Protected well	0	43.8	15.1	
Other [1]	4.1	9.2	2.6	
Person responsible for fetching water (%)	n =413	n=217	n=630	
Women	69	65	67.6	
Others [2]	31	35	32.4	
Time (minutes) required to fetch water (%)	n=404	n=216	n=630	
<30 minutes	20.1	43.8	28.3	< 0.001
30-60 minutes	35.6	23.5	31.4	
>60 minutes	44.3	32.7	40.3	
Median (25^{th}, 75^{th})	60 (30, 120)	30 (10, 120)	60 (20, 120)	

HH, Household; [1]Surface water (such as river, lake and pond), unprotected well; [2] men, children, maid, rented donkey cart; * *P*-values were for comparison of study sites using *Chi-square* tests;

6.3.2. Estimation of Household food insecurity and household hunger

Tables 6.2 and 6.3 present the food security situation of households classified on HFIAS and HHS scales. Affirmative responses to each of the nine occurrence items (Table 6.2) were twice or three times more in Halaba than Zeway households ($p < 0.001$). In addition, the median

[14] *Ensete ventricosum*, also known as false banana, is most common starchy staple and important food security crop in the southern parts of Ethiopia (6).

score of HFIAS and HHS were significantly higher for Halaba than Zeway study households ($p < 0.001$).

Table 6.2 Percentage of affirmative responses to the HFIAS and HHS occurrence items and median scores† of households from rural Halaba or Zeway in the four weeks preceding the interview during March-June, 2013, Ethiopia

Indicators (occurrence items) %	*Halaba*	*Zeway*	Combined	*P*-values*
	n=413	n=216	n=629	
Worry that the household would not have enough food	72.9	35.6	60.1	< 0.001
Not able to eat the kinds of food preferred	82.1	54.2	72.5	< 0.001
Eat a limited variety of foods	82.3	54.6	72.8	< 0.001
Eat some foods that you really did not want to eat	78.0	46.3	67.1	< 0.001
Eat a smaller meal than you felt you needed	75.3	43.1	64.2	< 0.001
Eat fewer meals in a day	69.7	36.6	58.3	< 0.001
No food to eat of any kind in your household	56.2	14.8	42.0	< 0.001
Go to sleep at night hungry	39.5	20.4	32.9	< 0.001
Go a whole day and night without eating	25.7	12.0	21.0	< 0.001
Median & percentiles (25^{th}, 75^{th})				
HFIAS	11(6, 16)	3 (0, 8)	8 (3, 14)	< 0.001
HHS	1 (0, 3)	0 (0, 0)	0 (0, 2)	<0.001

HFIS, Household Food Insecurity Access Scale; HHS, Household Hunger Scale; * *p*-values were for comparison of study sites using *Chi-square* tests for proportions and *Mann-Whitney U*-test (2-tailed) for median scores; †scores range from 0-27 on the HFIAS and 0-6 on HHS;

Summary measures of HFIAS and HHS are presented in Table 6.3. Only 15% of households in the pooled data were food secure. A significant majority of Halaba households (63%) were classified as *severely food insecure* compared with only 21% in Zeway ($p < 0.001$). Likewise, the classification of the households based on the newly developed HHS showed nearly 31% of all households experienced *moderate* to *severe* levels of hunger. Proportion of households that experienced both levels of hunger were twice as large in Halaba as those in Zeway ($p < 0.001$). No participant household from the Zeway community fell in the category of 'severe household hunger' whereas 13% did in the Halaba households.

6.3.3. Multiple variable analysis

Tables 6.4 and 6.5, respectively, present findings from the Multiple Classification Analysis using scores from the HFIAS and HHS as dependent variables. Each of the selected demand-supply side factors significantly predicted degree of household food insecurity in the study

Table 6.3 Prevalence of household food insecurity and household hunger based on HFIAS and HHS during the four weeks prior to the interview day between March-June 2013 in rural Halaba or Zeway, Ethiopia

	Halaba	*Zeway*	Combined	*P*-values*
	n=413	n=216	n=629	
Summary measures of HFIAS				
Food secure	5.3	33.3	14.9	<0.001
Food insecure	94.7	66.7	85.1	
Mildly food insecure	10.4	16.7	12.6	
Moderately food insecure	20.8	28.7	23.5	
Severely food insecure	63.4	21.3	49.0	
Summary Measures of HHS				
Little or no household hunger	62.2	82.4	69.2	<0.001
Household hunger	37.8	17.6	30.8	
Moderate household hunger	24.9	17.6	22.4	
Sever household hunger	12.9	0	8.4	

HFIAS, Household Food Insecurity Access Scale; HHS, Household Hunger Scale; * *P*-values were for comparison of study sites using *Chi-square* tests;

households (Table 4) and the overall model explained significant variation in the dependent variable [*F* (14) = 26.624, $p < 0.001$; R^2=0.405]. Mean scores for degree of food insecurity were significantly different among the levels of each demand related factors identified (i.e., number of under 5y of age children/household, physiological density, household TLU and household wealth). More under 5y of age children, higher physiological density, low TLU and lower wealth index were associated with a higher degree of food insecurity, after adjustment for other factors in the model. Likewise, supply side factors (i.e., women with no access to their own piece of land, women with work burden, half or less hectare of cultivable land size and frequency of crop production per year) also were associated with higher degree of household food insecurity based on mean scores. The community variable (Halaba households) had higher degree of being food insecure as well as not participating in government food security programs.

Most of these factors also significantly predicted the degree of experiencing household hunger (a more severe condition of food insecurity) (Table 6.5). The model itself explained considerable variation in the dependent variable (i.e., mean scores for degree of household hunger) and was very significant [*F* (14) = 9.884, $p < 0.001$; R^2=0.201]. Demand side factors such as household TLU and number of under 5y of age children/household were significant in the model, after adjustment for all other factors. Likewise, supply side factors, such as women's

Table 6.4 Mean score for degree of household food insecurity by selected explanatory variables using Multiple Classification Analysis, for the two districts combined, Ethiopia

Variables	Mean score for degree of household food insecurity [a]				
	N	Unadjusted	Eta (η)	Adjusted for Factor	Beta (β)
Women with access to their own piece of land					
No	411	10.25	0.313	10	0.25***
Yes	152	5.54		6.23	
Work burden of women [b]					
No long distance walk	151	6.35	0.238	8.29	0.063***
Longer distance walk	412	9.94		9.23	
Number of under 5 children per household					
One	332	8.64	0.085	8.56	0.076**
Two	216	9.63		9.54	
Three or more	15	7.13		10.19	
Physiological density [c]					
8 or less	369	8.09	0.184	8.76	0.046***
> 8	194	10.68		9.41	
Cultivated land size of households					
0.5 or less hectare	169	11.07	0.268	9.71	0.127***
0.6-1.0 hectares	231	9.26		9.37	
>1.0 hectares	163	6.43		7.67	
Frequency of food crop cultivation per year					
Once	255	6.72	0.308	8.43	0.075***
Twice	308	10.85		9.44	
Household Livestock					
Low (0-2.5 TLU)	309	10.17	0.237	9.79	0.135***
Average (2.5-5 TLU)	180	8.37		8.06	
High (>5 TLU)	74	5.49		7.82	
Wealth index of households					
Low (<4)	161	11.07	0.288	10.16	0.116***
Medium (4-8)	242	9.50		8.71	
High (>8)	160	6.10		8.20	
Location of community					
Halaba	378	11.26	0.487	10.75	0.379***
Zeway area	185	4.32		5.36	
Households involvement in food security programs					
No	509	9.05	0.03	9.14	0.075**
Yes	54	8.37		7.45	

R= 0.636; $\mathbf{R^2}$= 0.405; Grand mean =8.8; number of cases=563; ** significant at $p < 0.01$; *** significant at $p < 0.001$

Model: F (14) =26.624, $p < 0.001$

TLU, Tropical Livestock Unit, 1 TLU=~250kg of livestock; [a] Scores on household food insecurity access scale range from 0-27 and the higher the score, the greater the degree of food insecurity at household level; [b] using the length of time required for fetching drinking water as a proxy; [c] the ratio of number of persons in the household to the size of cultivable land in hectare;

Table 6.5 Mean score for degree of household hunger by various explanatory factors using Multiple Classification Analysis for the two districts combined, Ethiopia

Variables	Mean score for degree of household hunger [a]				
	N	Unadjusted	Eta (η)	Adjusted for Factor	Beta (β)
Women with access to their own piece of land					
No	412	1.34	0.217	1.3	0.179***
Yes	153	0.61		0.71	
Work burden of women [b]					
No long distance walk	151	0.74	0.163	1.01	0.06**
Longer distance walk	414	1.29		1.19	
Number of under 5 children/household					
One	333	1.03	0.099	1.01	0.11*
Two	217	1.33		1.32	
Three or more	15	1		1.48	
Physiological density [c]					
8 or less	371	1.03	0.107	1.16	0.02
> 8	194	1.36		1.1	
Cultivated land size of households					
0.5 or less hectare	169	1.5	0.203	1.36	0.126**
0.6-1.0 hectares	232	1.18		1.17	
> 1.0 hectares	164	0.72		0.87	
Frequency of food crop cultivation per year					
Once	256	.87	0.166	1.13	0.009**
Twice	309	1.37		1.15	
Household Livestock					
Low (0-2.5 TLU)	309	1.39	0.210	1.33	0.145***
Average (2.5-5 TLU)	182	0.99		0.95	
High (>5 TLU)	74	0.49		0.81	
Wealth index of households					
Low (<4)	161	1.47	0.191	1.3	0.068
Medium (4-8)	243	1.19		1.07	
High (>8)	161	0.73		1.09	
Location of community					
Halaba	378	1.47	0.313	1.4	0.253***
Zeway area	187	0.48		0.61	
Households involvement in food security programs					
No	511	1.15	0.019	1.16	0.045
Yes	54	1.06		0.94	

R= 0.448; $\mathbf{R^2}$= 0.201; Grand mean =1.13; Number of cases=565; * significant at $p < 0.05$; ** significant at $p < 0.01$; ***significant at $p < 0.001$; **Model**: F (14) =9.884, $p < 0.001$

TLU, Tropical Livestock Unit, 1TLU =~250kg livestock;

[a] Scores on household hunger scale range from 0-6 and the higher the score, the greater the chance of experiencing household hunger;

[b] using the length of time required for fetching drinking water as a proxy;

[c] the ratio of number of persons in the household to the size of cultivable land in hectare;

access to land, work burden on women, cultivable land size and frequency of production per year were significant predictors. The community variable (i.e., Halaba) was associated with higher risk of experiencing household hunger.

6.4. Discussion

The overwhelming majority of participant households from either community were found food insecure and nearly one in every three households in the combined data experienced moderate to severe household hunger. Halaba was significantly worse than Zeway on both scales. The study also found that most of the selected supply and demand side factors, as well as the community and institutional factors significantly predicted household food insecurity and hunger in the pooled data; however, the combined supply factors (i.e., women's access to own piece of land, cultivable land size of the household, work burden on women, frequency of crop harvest per year) appeared to have greater influence on food insecurity and hunger.

Roba et al. (Roba et al., 2015) also found very high levels (87%) of household food insecurity in a 2011 study that examined adolescent nutrition in the Halaba district. However, the proportion of households reported here as severely food insecure (63%) were much higher compared with only 16% reported by Roba et al. This difference may have been due to timing of data collection–i.e., how soon or late data were collected after main harvest season (~Oct-Dec) in the district (FAO, 2015). Data for this study was collected during the months of March–June whereas Roba et al. (2015) collected in February-March. Therefore, the finding of more households with severe food insecurity in this study may indicate limited food supply or economic inability to access food, and hence increased risk of household food insecurity in the months further away from harvest season.

In an adjacent rural district, Regassa (Regassa & Stoecker, 2012b) reported high levels (82% and 29%) of household food insecurity and hunger, respectively, although the study was conducted during December-January period, i.e., closer to crop harvest compared to ours (March-June). The vulnerability of households to food shortage and hunger, even shortly after main harvest, may indicate insufficient harvest due to poor productivity which itself arises from a combination of factors such as application of inadequate farm input (improved seed/fertilizer), dependence on climate change induced erratic rain fall, low irrigation use (FAO, 2015), a tenure policy that enforce state control of land and discourages sustainable investment by farmers on the land (Crewett, Bogale, & Korf, 2008; Nega, Adenew, & Gebre Sellasie, 2003) and small land holding size, arising from a geometric increase in population growth (Sewnet, 2015). For example, 70% of the study households reported a <1ha land holding but with high (6±2) average family size (Table 6.1). However, high prevalence of food insecurity is not limited to rural farming households as studies have shown similar trends in urban settings both in Ethiopia (Birhane et al., 2014; Endale et al., 2014) and in neighbouring Kenya (Kimani-Murage et al., 2014; Shinsugi et al., 2015).

As indicated by several studies in Ethiopia (Ali et al., 2013; Belachew, Lindstrom, Gebremariam, et al., 2013; Belachew, Lindstrom, Hadley, et al., 2013; Roba et al., 2015) and elsewhere (McDonald et al., 2015; Shinsugi et al., 2015; Young et al., 2014), household food insecurity, and the subsequent hunger, is one of the underlying causes of poor nutritional health outcomes in vulnerable household members. However, household food insecurity (and hunger) or food security itself is a function of social-economic, demographic, environmental and policy related factors interacting at national, regional, community or household levels, as outlined in the famous 'conceptual framework of malnutrition' by UNICEF (1990). This study has investigated a select group of some of these factors, conceptually organized as demand or supply, as well as community and institutional factors, and measured their effect on food insecurity and hunger at household level.

Supply side factors—women's access to land, household land-size, frequency of production per year and work burden of women–were significant predictors of food insecurity and hunger both in the bivariate (unadjusted) and multiple variable (adjusted for factors) analysis (Tables 6.4 & 6.5). Households where women had no access to their own farmland, traveled longer distances to fetch water (work burden) and households that had small land size (≤5ha) and produced crops twice/year had significantly higher mean scores on HFIAS & HHS scales ($p < 0.001$), indicating greater degree of food insecurity and hunger in these households. The direction of association of all supply side factors to food insecurity and hunger was as expected except 'frequency of crop production per year' in which more than once/year crop production did not appear to reduce vulnerability to food insecurity or hunger in both the adjusted and unadjusted models. This may indicate perhaps improving productivity is more important than the frequency of production. However further research may be required to establish the exact scenario.

Farmland is an important resource that determines food supply in communities that depend on farming as main livelihood. However, since most households in Ethiopia have smaller farmland due to the high population growth (Sewnet, 2015), increasing productivity per unit of land area is the next feasible option to ensure sufficient food supply for households. This in turn requires labor force and women play or can play a key role. The FAO and World Bank reports on the role of women in agriculture states that the goal of feeding the world cannot be realized without the contribution of women that make up significant part of the labour force (FAO, 2011, 2012; World Bank, FAO, & IFAD, 2009). Likewise, Mosse (Mosse, 1993), also emphasized the significant contribution of women in agriculture or any development. The current study showed households where women spend significant time going longer distances to fetch water had increased risk for food insecurity ($p < 0.001$).

Lack of access to land by women was also an important predictor of food insecurity and hunger ($p < 0.001$) where households in which women had their own piece of farmland had significantly lower scores (i.e., lower risk of being food insecure or experiencing hunger). This may be due to the relative flexibility women with access to land may have to make decisions on their produce whether to consume at home or sell. Allendorf (Allendorf, 2007) has shown that women with access to land had better decision making power at household levels and provided better care for children. Therefore, policies that minimize or eliminate the gender disparities in equal access to land should be put in effect.

From the identified demand side factors, households with the lowest livestock, in the lowest wealth category, with two or more under five years of age children and higher physiological density were at greater risk for food insecurity. Since physiological density is a function of land (limited resource) and household size, improving productivity of land and strengthening family planning services could assist efforts toward household food security. The geographic location of study communities was also a strong predictor; households from Halaba were twice as likely to experience food insecurity and hunger as those from Zeway. Other community level factors that were not captured in this study, such as market proximity, aggregate food supply, cultural beliefs/food taboos, history of susceptibility to drought, community level coping mechanism, may have contributed to the observed location difference in vulnerability, warranting further investigation. Households' involvement in the local food insecurity programs (institutional variable) showed that those who did not participate had greater chance of experiencing food insecurity and hunger. Unfortunately, households were not asked why they did not participate in food security programs despite the high prevalence of food insecurity and hunger in the area. Future studies may investigate whether the limited involvement in food security programs was due to lack of service coverage or refusal from the side of households.

While the aforementioned micro-level factors explained 41% (R=0.405) of the variation in the outcome variable, a great deal of remaining variation may be explained by other macro level variables such as, policies that affect aggregate food supply, which were not captured in the current model. One of such policy would be one that deals with land. The fact that about 85% of Ethiopia's population depend on agriculture makes land a key resource. Hence government policies on land administration (i.e., ownership, certification, transfer and women's access to land) affect food production and the subsequent household food security status. In Ethiopia, farmers have only "usufruct right" to land while the state owns the land (Crewett et al., 2008; Nega et al., 2003) which may raise concerns on the issue of food sovereignty. Food sovereignty, which pertains to the right of farmers to decide on their own production, distribution and marketing of food as well as ownership of farmland, is a bigger concept than food security (Cochrane, 2011). It advocates not just achieving food security, which places much emphasis on food availability and access without regard to the source of the food (imported verses local), but that farmers should own and decide on the process of achieving food security. Lack of land tenure security may significantly impact productivity and the subsequent household food supply as it may prevent farmers from fully investing on the land as though it were their own.

The existing land policy also allows the government of Ethiopia to lease land to foreign investors. Some have criticized and referred this as 'land grabbing' as the process has resulted in the eviction of indigenous people from their farm or pastoral land in parts of southern Ethiopia (Cochrane, 2011; Settee, 1999; The Oakland Institute, 2015). In recent years, the government has started implementing a land certification policy that aimed at benefiting female headed households and married women to improve their access and control of land thereby empowering them (UN-HABITAT, 2008). Some studies and practical experiences (Settee, 1999) also suggest that ensuring land right gives more fruits when local governments promote indigenous knowledge and practices such as preservation of community's natural environment to ensure sustainable food systems at community and household levels.

At a bigger scale, Ethiopia continues to face significant challenge in achieving food security at household and individual level. The 2014 Global Hunger Index (GHI) study ranked Ethiopia among the bottom few countries with severe levels (24.4%) of global hunger (Grebmer et al., 2014). The index is an average measurement of three indicators: undernourished population (% with insufficient caloric intake), prevalence of underweight children and level of child mortality before 5th birthday. Based on GHI classification, the severity of the observed hunger in Ethiopia was set as 'alarming'. In 2015, Ethiopia was faced with severe drought in parts of the country due to lack of rain and the food security situation has significantly deteriorated as 8.2 million people were food insecure by October (double the number from previous year in the same period) (FAO, 2015). This also affirms the presence of challenging food environment for vulnerable household members in the country, requiring systematic and aggressive efforts to tackle the problem at household, community and policy levels.

The study's limitation: It failed to provide a full-picture on the pattern of food insecurity on a different season in either districts due to cross-sectional nature of the design. The study also did not collect detailed information on areas such as farming practices, use of technology (improved seed, fertilizer, farming techniques) and market access which might help explain why producing crops twice/year did not reduce vulnerability to food insecurity or hunger. The study recommends further research to explore these factors and also the actual dietary intakes and overall consumption pattern of vulnerable family members, such as mothers and children, to estimate the level of risk of inadequacy for programmatic purpose.

6.5. Conclusion

This study has reported unacceptably high prevalence of household food insecurity in both districts (95% in Halaba and 67% in Zeway). Household hunger was 38% in Halaba and 18% in Zeway. Both food insecurity and hunger were significantly greater in Halaba ($p < 0.001$), warranting large scale investigation into the farming system factors. Both supply and demand factors were significant in determining household food insecurity and hunger ($p < 0.01$); however, supply factors such as women's access to land, land size, frequency of production and work burden had greater leverage than the demand factors. Levels of food insecurity and hunger in both communities were very high and of serious concern. The study recommends increasing the food supply, and its subsequent accessibility, for households through enhancing women's access to land, improving income through savings and wealth accumulation, introducing more inclusive programs for women's participation and reducing household work burden and enhancing productivity of cultivable land.

Chapter 7 Comparison of maternal and child nutrition in pulse or cereal growing rural communities of Ethiopia (Study 4)

Abstract

In pulse- and cereal-based agricultural communities, the nutrition of mothers and children (<5y) was compared through anthropometric and dietary assessment. A baseline comparative study was conducted in purposively selected pulse (n=413) and cereal-growing (n=217) Ethiopian communities, from rural Halaba and Zeway, respectively. Dietary diversity scores (DDS) and consumption indexes of selected food groups were assessed; median intakes of energy, protein, Fe, Zn, Ca were determined from single-day weighed food records. Anthropometric assessments were done to estimate undernutrition in mothers-children. Median energy and nutrient intakes for pulse-mothers, but not children, were significantly higher than for cereal-mothers ($p < 0.01$); Median DDS for mothers-children were 3, out of nine food groups, in either community; the consumption index score of pulses, though higher in the pulse-community ($p < 0.001$), was generally low, denoting pulse consumption only once or twice/week; consumption from animal sources was minimal. Frequency of ANC visits, household land size, child/maternal age, being from a pulse or cereal community, frequency of consumption of diary products, child stunting status, as well as gender sensitive factors, such as poor access to land and work-burden on women, predicted anthropometric markers of nutritional status in mothers or children in the pooled data. Pulse produce was mostly sold at market, and women had limited control; pulse mothers' knowledge of the nutrition benefits of pulses was lower ($p < 0.01$). Poor DDS, energy and nutrient intakes, as well as lower frequency of consumption of nutritious crops, such as pulses, or of animal source foods were found in both communities. The unexpected finding of greater undernutrition in the pulse-growing community (with relatively better nutrient intake for mothers) may be due to the work-burden on women or other nutrient deficiencies. The pulse-community could benefit from a nutrition intervention that educates about the nutrition and other benefits of pulses. Overall, this community baseline study indicates a need to strengthen nutrition service delivery programs to mothers-children.

Key words: Pulse or cereal growing communities, maternal undernutrition, diet diversity, child stunting, pulse consumption, rural Ethiopia

7.1. Introduction

The nutrition of women and children in rural Ethiopia continues to suffer from inadequacy as diets are of limited variety, providing insufficient energy and nutrients. Studies in rural parts of southern Ethiopia have reported low dietary diversity, higher micronutrient (iron & zinc) deficiencies and limited consumption of animal source foods as characteristics that frame the nutrition context of women and young children (Abebe et al., 2008; Gebremedhin et al., 2011; Gibson et al., 2009; Gibson et al., 2008; Tessema et al., 2013). Given the similarities in socio-economic profiles, these poor dietary practices can be assumed to be characteristics of other parts of rural Ethiopia. This poor dietary practice has been reflected in the poor nutritional status of rural women and children <5years of age who, in the past 15 years, have continued to present not only high levels, but 45% to 72% higher levels, of undernutrition compared with their urban counterparts (CSA, 2014; CSA & ICF International, 2012; CSA and ORC Marco, 2006). One area this situation could be mitigated is by looking into the dietary habits of the women and children.

Pulses (low fat legumes including dry beans, peas, chickpeas and lentils) are the second most important food crops in Ethiopian agriculture next to cereal grains (CSA, 2009, 2015a, 2016). The nutrition potential of pulses can be leveraged to improve nutrition in resource poor settings. Pulses are known to provide high protein compared to cereal crops and also provide other micronutrients (Ofuya & V., 2005; Pulse Canada, 2012, 2016). Compared to animal source foods, pulses are cheap and alternative sources of protein and micronutrients, particularly in communities where animal source protein is not affordable and/or available. Pulses may have many other benefits as a source of cash income as pulses sell at higher prices than cereals; a source of natural fertilizers (nitrogen fixers), meaning that farmers can apply less nitrogen fertilizer to their fields; and as important food security crops because they withstand moisture stress and have a shorter maturation period (IFPRI, 2010).

However, the benefits of pulse agriculture, particularly its link to nutritional health of vulnerable populations in Ethiopia have not been well documented. Adding pulses to the diet or using the income generated from pulse sales to buy other nutritious foods can improve the diversity in the diet, which in turn provides more nutrients to an individual's diet. Dietary diversity, i.e., consumption of a variety of foods from different food groups, is a proxy measure of the quality of diet and micronutrient intake of individuals (Kennedy et al., 2011). Only one recent study was found that documented the dietary intakes, dietary diversity and overall nutritional status of populations in traditionally pulse growing communities in Ethiopia (Roba et al., 2015). The study examined adolescent nutrition and links to pulse intake. A few other studies have shown improvements in knowledge, attitudes and behaviours among mothers and dietary diversity energy intakes for young children who participated in nutrition education to promote pulse complementary foods for infants and young children (Kebebu et al., 2013; Mulualem, Henry, Berhanu, & Whiting, 2016; Negash et al., 2014).

It should be noted that cereal grains such as teff, sorghum, barley, wheat, and maize are the main staples in the Ethiopian diet followed by pulses (Seyoum et al., 2011). Though pulses provide multiple benefits, including affordable protein and micronutrients in the diet, practicing pulse-agriculture may not necessarily mean more pulse consumption. One reason could be that households may decide to sell all their pulse produce to generate cash income. Neither does it mean households in non-pulse producing communities consume less or no pulses as they could purchase their pulses from the market place. Evidence is limited to fill this gap in knowledge. This study is the first to compare dietary intakes, dietary diversity and overall nutritional status of mothers and children in pulse versus cereal growing communities.

The purpose of this study was, therefore, to compare the dietary intakes, including dietary diversity, and nutritional status of mothers and their young children from a traditionally pulse-growing community (Halaba) and a predominantly cereal-growing community near Zeway town, in rural Ethiopia. Considering the potential of pulses to improve nutrition and generate household income, the study hypothesized that mothers and children living in pulse-growing communities would be better nutritionally compared with mothers and children in a similar but mainly cereal-based community. We assessed average intakes of energy and selected nutrients, dietary diversity, consumption index of selected food groups, pulse related background characteristics and other socioeconomic conditions. Associations with nutritional status indices were explored in a multiple variable analysis.

7.2. Methods

7.2.1. Study setting, participants and design

The study was conducted in two rural locations in Ethiopia, two pulse-growing communities from the Halaba district and one cereal-growing (non-pulse) community from *Adami-Tulu-Jido-Kombolcha* (ATJK) districts, near Zeway town. The two districts (also known as

Woredas) are located in the SNNPR and Oromiya Regional State, respectively. The selection of the study sites (pulse or cereal growing communities, in line with the objective of this study) was purposive as these areas were locations for a larger collaborative research project between Hawassa University in Ethiopia and the University of Saskatchewan in Canada, of which the current study was a part. The specific communities in each district were selected in consultation with the local agricultural offices based on whether communities were mainly pulse or cereal growing (i.e., whether the majority of the farming households grow one or more pulse crops or not). Accordingly, two leading pulse growing communities from Halaba, namely *Guba-Sherero* and *Holagoba-Kukie*, and one cereal growing community from ATJK, namely *Edo-Qontola*, were selected for this comparative study. Henceforth, the communities are referred as *pulse* or *cereal* growing communities. More description of the study communities is found in section 3.2 of Chapter 3.

The study participants in both the pulse and cereal communities were mothers and their <5y old children. A total of 413 and 217 mother-child pairs were randomly selected in a cross-sectional study design from the two pulse and one cereal growing communities, respectively. The study was approved by the University of Saskatchewan Behavioural Ethics Board (#12-357) and permission was received from the health bureaus of the respective regions where the study was conducted. Participant mothers gave oral consent to participate in the study, which was then confirmed by writing down their name in the consent form by the local research assistants.

7.2.2. Data collection, tools and analysis

Data used for this study included weighed food (dietary intake) data, dietary diversity data based on FAO's nine food groups, food frequency data for consumption of pulse and other food groups, a summary of anthropometric measures and pulse production and consumption related background characteristics.

As described in Chapter 3, a structured questionnaire was used to collect the pulse agriculture related information, diet diversity and the food frequency related data. Separate forms were used to obtain a single day weighed food record data (in subsamples of mothers and children) and anthropometric measurements. Trained female data collectors with some post-secondary training, mostly nurses, collected all questionnaire based data. The weighed food record data collection was also done by the same female data collectors on a separate day by spending the entire day (7am to 7pm) at the home of the participants observing food preparation and intake.

Sample size and selection of participants for the weighed record have been described in chapter 3. Normally, the data collector would arrive at the home of the participant in the early morning (before the breakfast meal) and spend the entire day with the mother and the child (6-59 months of age) by weighing and recoding every food and drink the mother or child consumed for that day until the evening meal. The whole process was supervised at the field level by the principal researcher and nutrition B.Sc. graduate research assistant. All anthropometric measurements were done by the principal researcher along with research assistants.

Analysis of weighed food record data: each completed weighed food record form for the mother and child was coded with the subject code number. A separate table was created for each subject, labeled with the subject's code, on Excel spreadsheets, and all foods and drinks consumed by the mother or the child were listed in their respective tables. Prior to entering the list of foods on the spreadsheet, each food and drink consumed was coded according to their food group. The codes indicated both the food group and specific food in that food group. A local food composition table was constructed on a spreadsheet once all foods and drinks were entered in separate tables created for each participant. The local food composition table included a list of all foods and drinks participants consumed along with energy and nutrient content per 100g of each consumed food item. Energy and nutrient values for most foods were obtained from Ethiopian Food Composition Tables (EFCT) (EHNRI, 1998a, 1998b). Nutrient values of some foods which were not on the EFCT were obtained by analysing samples of those foods in the laboratory (details of the procedure has been described in Chapters 3 and 5). In this way, energy and nutrient values per 100g of all foods/drinks listed in the local food composition table were completed.

Energy, protein, iron, zinc and calcium contents per actual amount of each food/drink consumed at each meal or snack were calculated for mothers and children separately. Next, the totals (of energy, protein, iron, zinc & calcium) from all foods/drinks of the single-day-weighed food records were calculated. Finally, the totals of energy and selected nutrients were transferred to an SPSS spreadsheet to calculate average energy and nutrient intakes of the group. Then, median energy and nutrient intakes were compared between pulse and cereal group mothers and children. Median energy and nutrient values of the mothers were also expressed as percent of weight-adjusted[15] Estimated Average Requirement (EER) (FAO, 2004) and Recommended

[15] EER was adjusted for the size of the mothers by using the average weight of the mothers in the study.

Nutrient Intakes (RNI) (FAO & WHO, 2004). Protein RNI values for the mothers were taken from WHO/FAO/UNU and adjusted by median weight of the mothers (WHO, FAO, & UNU, 2007). Median intakes for children were not expressed as percentage of EER or RNI due to the existence of multiple RNIs based on age classes. Since the main emphasis in this study was to compare average dietary intakes of children between *pulse* versus *cereal* groups, values were not disaggregated across age classes to avoid ending up with too few observations to make meaningful comparisons between groups.

The dietary diversity information was analysed by reducing the 16 food groups into nine main food groups, as outlined in the FAO guideline (Kennedy et al., 2011). Then, the proportion of mothers or children who ate from specific food groups was reported. The overall diet diversity scores (DDS) were also calculated for both children and mothers in pulse or cereal communities and reported as medians with 1st and 3rd quartile values.

The food frequency questionnaire was designed to obtain information on frequency of pulse or pulse-based food consumption, along with other food groups such as fruits and vegetables and animal source foods. Frequency of consumption scores ranged from 1-4 (a score of 1= food group consumed twice or less per month or never, 2= once or twice per week, 3= 3-6 times per week, and 4= food consumed ≥ once per day). For each case, the consumption index was generated by adding all consumption frequencies of foods listed in one food group and dividing it by the total number of foods listed in that food group (e.g., consumption frequencies of 4-5 different types of pulses/related foods were reduced to the pulse consumption index). In this way, consumption indexes were calculated for pulses, animal source foods and fruits and vegetables. Then median (1st, 3rd quartiles) of the consumption indexes were reported for each community.

Proportions were compared between pulse or cereal groups using chi-square tests, whereas median energy and nutrient intakes as well as median consumption indexes and DDS were compared using the Mann Whitney *U* test between the pulse and cereal groups, for the mothers and children separately. A $p < 0.05$ was considered as a statistical significance.

7.3. Results

This section presents findings on pulse production and consumption related variables, dietary intake information based on weighed food record, dietary diversity and food frequency measures, as well as determinants of nutritional status in pulse or cereal growing communities.

Background information about the study communities has been presented in previous chapters (4-6).

7.3.1. Pulse production, knowledge, attitude and practices related to consumption

Table 7.1 presents a summary of findings based on pulse agriculture and related information to consumption by mothers and their children in participating households. Some qualitative results are also included in the text to complement the findings in the table. Accordingly, almost all households from the pulse growing community identified themselves as pulse growers compared with less than half in the cereal growing community ($p < 0.001$). The kidney bean is the most dominant pulse grown in the pulse community (> 93%), whereas kidney beans and haricot beans were the pulses mainly grown by those households from the cereal group that reported growing some pulses. Production was mainly for cash income and home consumption, especially in the Halaba communities. The median value for the amount of pulses produced by households, in the most recent harvest prior to the interview, was 275 and 250 kilograms for the pulse and cereal growing communities, respectively, and was not significantly different. However, pulse households in the 1st quartile produced twice as much as cereal households in the same quartile.

Men were in charge of pulse production, particularly in the pulse growing communities, as only 2.6% of women reported co-decision making on production along with men. Although men still dominated when taking charge of pulse production in the cereal community, a significantly higher proportion (38%) of women reported having shared control on produce ($p < 0.001$). A majority of women in either community (74% in pulse and 70% in cereal) had no access to land where they could grow their own preferred crops. Those women that did have access to land reported growing crops such as maize, khat, kale, millet, sorghum and potatoes.

Consumptions of pulse-based foods by mothers-children was common in both communities but the majority (76%) of households in the cereal community obtained (purchased) their pulses from market. A significant proportion of households (39%) in the pulse communities also purchased their pulses from market. Most commonly used pulses for food were kidney beans and peas in pulse and cereal communities, respectively. The haricot bean was the least consumed in either community. Qualitative results also indicated that most common dishes made from

Table 7.1 Pulse agriculture, nutrition and related practices of mothers in Halaba or Zeway

	Pulse-growing	*Cereal-based*
Grow any pulse (%)	n=413	n=217
Yes	94.2***	46.1
Purpose of production (%)	n=389	n=93
For cash income & home consumption	73.4***	54.8
Cash income only	6.3	23.7
Home consumption only	20.3	21.5
Size of most recent pulse harvest (kg)	n=376	n=88
Median (25^{th} %, 75^{th} %)	275 (200, 400)	250 (100, 400)
Pearson in charge of production (%)	n=386	n=101
Men	97.4	62.4
Men & women	2.6***	37.6
Mothers with access to own cultivable-land (%)	n=408	n=211
Yes [c]	25.7	29.9
Mother-child consumption of pulse based foods (%)	n=413	n=207
Yes	90.1	87
Source of pulse for consumption (%)	n=409	n=196
Own production & purchase	40.4	15.3
Purchase	39.1	75.6
Own production	20.5	7.1
Food aid	0	2
Common pulses used for food (%)	n =386	n=177
Kidney bean	95.9	35.8
Pea	46.3	81.9
Faba bean	20.5	37.9
Lentil	31.5	66.7
Chickpea	13.7	20.9
Haricot bean	6.7	7.3
Mothers' attitude to pulse foods (%)	n=412	n=199
Like	77.2***	95
Dislike/not sure	22.8	5
Knowledge of pulse nutritional benefits (mothers) (%)	n= 412	n=207
Yes	40.8**	54.6
Intend to increase pulse consumption in future (%)	n=413	n=207
Yes	68.5	74.4
Intention to increase pulse production (%)	n=390	n=208
Yes	59.2	52.9

, * significant between groups at $p < 0.01$ and $p < 0.001$, respectively (*Pearson's chi-square test*);

pulses include: beans stew, boiled beans, *shiro wot* (stew made from roasted pea/faba bean flour) which, then, is served with bread/ Injera[16] (made from maize, sorghum, millet) and boiled beans are served alone or with coffee.

The majority of mothers from both communities expressed positive attitudes toward pulses/pulse-based foods (i.e., they 'liked it'). However, the proportion of mothers that expressed positive attitudes was significantly more in the cereal than the pulse growing community ($p < 0.001$); in addition, significantly more mothers from the cereal community said they knew some nutritional benefits of pulses than did the mothers from the pulse community ($p < 0.01$). Intentions to increase consumption or production of pulses in the future were fairly high but did not differ between groups. Some of the nutritional benefits mothers mentioned (and reasons for intending to increase consumption of pulses) include the following: "pulses provide energy and strength for the body," "protect from anemia," "good for overall health," "good for blood," "used as sauce/complement other foods" and "good for my child."

7.3.2. Intakes of energy and selected nutrients

Energy and selected nutrient intakes by mothers and their children 6-59 months of age are summarized in Table 7.2. Median intakes of energy, protein, iron, zinc, and calcium were all significantly higher for mothers from the pulse community compared with those from the cereal growing community ($p < 0.001$). However, compared with Recommended Nutrient Intakes (RNI), median energy intake by pulse mothers was only 58% of the RNI, assuming average weight of the mothers and a median score for a vigorous or vigorously active lifestyle (taking into account the daily hardships of rural mothers in Ethiopia). Percent RNIs for other nutrients for pulse mothers was above requirements, except calcium, which was 90% of the RNI. Median energy and nutrient intakes of the cereal mothers were all below requirements, except for protein. In contrast, median intakes of energy, protein and zinc were significantly lower for the children from the pulse growing area ($p < 0.05$). There were no significant differences in intakes of iron and calcium between pulse and cereal children.

[16] Injera is a flat bread mostly made from a cereal called 'teff' which is common only in Ethiopia. But Injera can be made from other cereals such as maize, sorghum and millets.

Table 7.2 Dietary intakes of energy and selected nutrients from one-day weighed food record data: median (1st, 3rd quartile)

	Pulse growing		Cereal growing	
	Mothers (n=137)	Children (6-59 months) (n=137)	Mothers (n=72)	Children (6-59 months) (n=72)
Energy (kcal)[a]	1574 (1270, 1970) **	408 (221, 585) **	1157 (864, 1499)	549 (358, 779)
RNI/EER	2700	-	2700	-
% RNI	58%	-	43%	-
Protein (g)	58 (43, 65) **	15 (8, 23) *	42 (32, 55)	18 (11, 31)
RNI	42	10-17	42	10-17
% RNI	138%	-	100%	-
Iron (mg)	62 (44, 78) **	15 (8, 26)	44 (29, 62)	17 (8, 28)
RNI	58.8	18.6-12.6	58.8	18.6-12.6
% RNI	105%	-	75%	-
Zinc (mg)	13 (10, 16) **	3 (2, 5) **	9 (7, 13)	4 (3, 7)
RNI	9.8	8.4-9.6	9.8	8.4-9.6
% RNI	133%	-	92%	-
Calcium(mg)	903 (592, 1203) **	214 (112, 365)	448 (295, 651)	213 (78, 466)
RNI	1000	400-600	1000	400-600
% RNI	90%	-	45%	-

[a] The daily recommendation of 2700 kcal was taken from FAO/WHO/UNU joint expert consultation report for human energy requirement (FAO/WHO/UNU, 2004) and adjusted for size of the women using average weigh (50kg) of the mothers in the study and also assumes a physical activity level of 2.2 (the median for vigorous or vigorously active lifestyle) for non-pregnant and non-lactating women; *significant at $p < 0.05$ and **significant at $p < 0.01$ *(Mann-Whitney U test, between communities); EER, estimated energy requirements;* RNI, recommended nutrient intake: assumes 5% bioavailability for iron & low bioavailability for zinc, based on WHO/FAO recommendations (WHO/FAO, 2004). RNI values for protein are based on WHO/FAO/UNU recommendations (WHO/FAO/UNU, 2007) and were adjusted for the size of the mothers by their average weight;

7.3.3. Diet diversity

Data on a single 24 h dietary diversity recall, collected on weekdays and weekends to represent a week, showed that most mothers and children in both communities consumed ‘starchy staples’ with minimal consumption from animal source foods (Table 7.3). Almost exclusively, the item that was consumed in the ‘dark leafy vegetables’ group was Ethiopian *kale* for both mothers and children in

Table 7.3 Food groups consumed (%) and diet diversity scores (DDS) for mothers and children ≥ 6 months) in the day and night preceding the interview day

Food groups	Pulse growing		Cereal growing	
	Mothers n=413	Children n=316	Mothers n=216	Children n=199
Starchy staples	100	86.7	100	94 *
Other fruits and vegetables[1]	97.8 **	70.9	92.1	75.9
Dark green leafy vegetables[2]	91.3	56	78.2	56.3
Legumes, nuts and seeds[3]	43.1	29.8	38.4	26.6
Milk and milk products	11.9	21	25 ***	39.2 **
Meat and fish	0.7	0.6	4.6 *	4 *
Eggs	1.7	4.7	0.5	4
Organ meat	0	0	0	0
Other vitamin A rich fruits and vegetables	0.7	1.6	0.5	0
Median (1st, 3rd quartile) DDS	3 (3, 4)	3 (2, 4)	3 (3, 4)	3 (2, 4)

[1] Mostly onion, tomatoes and green pepper which were usually added as spices/condiments than as main food ingredients; [2] The reported food consumed in this food group was *Ethiopian kale* (almost 100% of the time); [3] Mostly kidney beans, haricot beans, lentils, pea flour (*'Shiro Wot'*) were reported; $^{*, **, ***}$ significant at $p < 0.05$, $p < 0.01$ and $p < 0.00$ respectively, between groups (*Pearson's chi-square test*);

either community. The percentages of mothers and children that consumed foods from 'legumes and nuts' during the day and night preceding the survey day were not significantly higher in the pulse than the cereal group. In contrast, the proportion of mothers ($p < 0.001$) and children ($p < 0.01$) that consumed 'milk and milk products' was higher in the cereal than pulse communities. Consumption from other food groups was minimal or non-existent in both groups.

Based on the nine food groups of FAO, the median value on dietary diversity scores (DDS) for both mothers and children from either community was only three (3). The results also showed only three (3) food groups (i.e., 'starchy staples', 'other fruits and vegetables' and 'green leafy vegetable') were consumed by ≥50% of the mothers and their young children in either community.

7.3.4. Consumption of common pulses and other foods based on food frequency questionnaire

Responses from mothers on their own and their children's consumption frequency of some common pulses and other food groups are summarised as consumption indexes in Table 7.4. An

Table 7.4 Consumption index, based on food frequency questionnaire of pulse and other food groups: median (1st, 3rd quartiles)

	Pulse growing	Cereal growing
Consumption index for mothers	n=413	n=204
Any animal product (meat/fish/poultry/dairy)	1.25 (1, 1.75) ***	1.5 (1.25, 1.75)
	n=411	n=214
Any fruits or vegetable	2.5 (2, 3) ***	2.5 (1.5, 2.5)
	n=413	n=205
Pulse (lentil/peas/kidney bean/broad bean)	2 (1.75, 2.5) ***	1.5 (1.25, 2)
Consumption index for children (6-59months)	n=289	n=177
Any animal product (meat/fish/poultry/dairy)	1.25 (1, 1.75) ***	1.5 (1.25, 1.75)
	n=282	n=187
Any fruits or vegetable	2.5 (2.0, 3.0) ***	2.5 (1.5, 2.5)
	n=287	n=179
Pulse (lentil/peas/kidney bean/broad bean)	2 (1.5, 2.5) ***	1.5 (1.25, 2)

Note: Scores ranged from 1-4 (a score of 1= food group consumed twice or less per month or never, 2= once or twice per week, 3= 3-6 times per week, and 4= food consumed ≥ once per day); ***Significant at $p < 0.001$, *Mann-Whitney U* (2-tailed)

index closer to 1 means consumption from a particular food group is only 'twice or less or never' per month, whereas an index closer to '4' indicates a consumption frequency of 'once or more than once' per day. Accordingly, the median consumption index of both 'pulses' and 'fruits and vegetables' was significantly higher for mothers and children in pulse than cereal group ($p < 0.001$). However, consumption indexes for 'animal source foods' were significantly higher in cereal than pulse mothers and children ($p < 0.001$).

7.3.5. Multiple classification analysis on predictors of child height-for-age z-score and maternal MUAC

In multiple regression analysis, the effects of selected household and individual level factors on child and maternal anthropometry (height-for-age z-score and MUAC, respectively) are shown in Tables 7.5 and 7.6 based on pooled data that included both pulse and cereal communities. In Table 7.5, the regression models for HAZ of children were very significant both in pulse and cereal communities, predicting about 25% of the variation in the outcome variable (R^2: 0.248), $p < 0.001$. After adjustment for all other factors in the model, child age ($p < 0.001$), being from the pulse or cereal community ($p < 0.001$), household size ($p < 0.001$), size of land

Table 7.5 Predictors of child height-for-age-z scores (HAZ), using Multiple Classification Analysis, in pulse or cereal growing rural communities, Ethiopia

Variables	Mean HAZ				
	N	Unadjusted	Eta (η)	Adjusted for Factor	Beta (β)
Household size					
<6	209	-2.19	.147	-2.19	.147***
6 or more	284	-1.72		-1.72	
Husband's educational status					
No formal education	223	-1.99	.040	-1.82	.056
Primary level	178	-1.87		-2.00	
Post-primary level	92	-1.84		-2.00	
Child sex					
Female	254	-1.82	.064	-1.83	.055
Male	239	-2.03		-2.01	
Household cultivated land size					
0.5 or less hectare	158	-2.09	.145	-2.14	.111*
0.6-1 hectare	202	-2.04		-1.91	
>1 hectare	133	-1.54		-1.68	
Maternal age (in years)					
15-24	104	-1.85	.026	-1.69	.075*
25-34	312	-1.93		-1.98	
35-49	77	-1.98		-2.00	
Number of ANC visits					
<4 visits	333	-2.00	.069	-2.00	.074
≥4 visits	160	-1.76		-1.75	
Age of child (in months)					
<6	82	-.85	.362	-.63	.449***
6 – 23.99	234	-1.81		-1.76	
≥ 24	177	-2.55		-2.72	
Work burden on mothers [a]					
No	134	-1.89	.011	-2.04	.044
Yes	359	-1.93		-1.88	
Household sanitation facility					
Unimproved	221	-1.95	.017	-1.96	.024
Improved	272	-1.89		-1.89	
Community					
Pulse producer	338	-2.09	.152	-2.22	.274***
Cereal-based	155	-1.56		-1.27	

R= 0.498; $\mathbf{R^2}$= 0.248; Grand mean =-1.92; Number of cases=493; *significant at $p < 0.05$; ***significant at $p < 0.001$; **Model**: F (14) =2.163, $p < 0.001$

Abbreviations: ANC, Antenatal clinic; η= coefficient for the bivariate association; β= coefficient for the multivariate association; [a] work burden was measured using distance travelled to fetch water (half hour or longer per trip) as a proxy;

Owned by the household ($p < 0.05$) and maternal age ($p < 0.05$), in order of importance, were significant predictors of HAZ of children in both communities.

After adjustment for all other factors included in the model, the mean HAZ score significantly dropped (became worse) for older children (≥24 months), whereas children in households of larger family size (≥ 6 members) appeared to have better HAZ scores compared to those in households with <6 membership. The HAZ scores for the children ≥24 months were much lower than the grand means (overall average) of all factors. Being from the pulse rather than cereal-based community meant significantly lower HAZ score. Likewise, the HAZ score of children from households with smaller cultivable land size tended to be lower, whereas that of children of younger women appeared to be higher compared with those of older women.

Other factors in the model did not show significant influence on HAZ scores though they showed some trends. For example, children whose mothers had four or more ANC visits during the most recent pregnancy and children who lived in households with access to improved sanitation facility generally had better HAZ scores.

Table 7.6 provides similar information on predictors of maternal mid-upper arm circumference (MUAC). Variables in the adjusted model that significantly predicted variation in maternal MUAC based on pooled data from both communities were number of ANC visits, amount of land owned by household, household size, frequency of consumption of dairy products by mothers, work-burden on mothers, child stunting status and access to own land by mothers, in order of importance. The overall model significantly explained about 10.2% of the variation in the dependent variable ($R^2 = 0.102$, $p < 0.001$).

The direction of association for those variables that significantly predicted variation in maternal MUAC was as expected, except for household size. For example, the mean MUAC of mothers were significantly higher for those mothers who had more ANC visits or mothers in households with larger amount of cultivable land, or for mothers who reported more frequent consumption of dairy products, or those who had no work burden. Other variables included in the model, such as pulse consumption, frequency of poultry product consumption or being from pulse or cereal growing community, did not have significant effects on maternal MUAC in the pooled data.

Table 7.6 Predictors of maternal mid-upper arm circumference (MUAC), using Multiple Classification Analysis, for mothers from pulse or cereal growing rural communities, Ethiopia

Variables	Mean MUAC (in centimeters)				
	N	Unadjusted	Eta (η)	Adjusted for Factor	Beta (β)
Household size					
<6	188	24.3	.143	24.4	.097**
6 or more	262	25.1		25.0	
Pulse consumption index for mothers					
≤2 (Less frequent consumption)	288	24.7	.000	24.7	.000
>2 (More frequent consumption)	162	24.7		24.7	
Child's stunting status					
Not stunted	224	25.0	.102	24.9	.066*
Stunted	226	24.5		24.6	
Household cultivated land size					
0.5 or less hectare	147	24.2	.174	24.3	.108**
0.6 - 1 hectare	183	24.7		24.8	
>1 hectare	120	25.5		25.1	
Mothers access to land (own)					
No	333	24.6	.103	24.6	.061*
Yes	117	25.2		25.0	
Number of ANC visits					
<4 visits	305	24.4	.185	24.4	.166***
≥4 visits	145	25.5		25.4	
Frequency of consumption of any dairy					
Less frequent (twice or less/month)	171	24.3	.131	24.4	.101*
More frequent (1-2 times or more/week)	279	25.0		25.0	
Work-burden on mothers [a]					
No	120	25.3	.118	25.1	.087*
Yes	330	24.5		24.6	
Frequency of consumption of any poultry					
Less frequent (twice or less/month)	334	24.7	.052	24.7	.018
More frequent (1-2 times or more/week)	116	25.0		24.9	
Community					
Pulse producer	319	24.6	.084	24.7	.022
Cereal-based	131	25.1		24.8	

R= 0.319; $\mathbf{R^2}$= 0.102; Grand mean =24.73; Number of cases=450; *significant at $p < 0.05$; **significant at $p < 0.01$; ***significant at $p < 0.001$; **Model**: F (11) =1.579, $p < 0.001$

Abbreviation: ANC, Antenatal clinic; η= coefficient for the bivariate association; β= coefficient for the multivariate association; [a] work-burden was measured using distance travelled to fetch water (half hour or longer per trip) as a proxy;

7.4. Discussion

The objective of this study was to compare the nutrition of mothers and young children from pulse or cereal growing communities through assessments of dietary intakes, dietary diversity, frequency of consumption and pulse-agriculture related practices. The study found that maternal dietary intake of energy and the selected nutrients (i.e., protein, iron, zinc, calcium) were significantly better for mothers in the pulse growing communities than in the cereal growing community. Despite this, energy, protein and zinc intakes of children were lower in pulse growing communities than the cereal group, while intakes of other nutrients did not differ among children between communities. Median dietary diversity scores and consumption from various food groups, based on the 24 h recall, did not differ between communities in either mother or child groups—the exception was consumption of 'milk and milk products' and some 'meat and fish,' which were reported by a higher proportion of cereal mothers and children. Consumption indexes for 'pulse' and 'fruits-vegetables' were significantly better in both mothers and children of the pulse community than the cereal growing communities. However, consumption indexes for 'any animal product' were significantly higher for mothers and children in the cereal community.

Despite the study's hypothesis and the observed higher maternal energy and nutrient intakes, and better consumption indexes of 'fruits and vegetables' and 'pulses', higher levels of maternal undernutrition and child stunting were found in the pulse than cereal-growing communities, based on anthropometric findings reported in Chapter 4. Factors common to both communities and which significantly predicted HAZ in children include: child age, being in pulse or cereal community, household size, household land size and maternal age. It is worth noticing that larger household size unexpectedly showed protective effect on HAZ and maternal MUAC (i.e., significantly higher HAZ and MUAC scores for those children and mothers from larger households).

Moderate to high levels of maternal undernutrition is a concern repeatedly documented both in national surveys and smaller studies in Ethiopia (CSA & ICF International, 2012; EHNRI, 2010; Negash, Whiting, Henry, Belachew, & Hailemariam, 2015; Regassa & Stoecker, 2012a). Studies that specifically looked into the actual dietary practices or estimated actual energy and nutrient intakes in mothers or rural women of reproductive age have been limited. Despite the strong evidence (Black et al., 2008; Black et al., 2013; Horton, 2008; Lartey, 2008;

Victora et al., 2008) that improving nutrition of mothers sets the foundation for better nutritional status of both the child and mother, research somehow appears to have focused more on infant and young child feeding practices, with limited attention to the dietary practices of the mothers themselves—beyond the rhetoric that maternal nutritional status is vital for ensuring that of the child. This could be due to the strong advocacy and emphasis on improving childhood nutrition, particularly of infants and young children under the age of 24 months, and as a result, a number of studies in Ethiopia tend to focus on nutrition practices of breastfeeding and complementary feeding children.

This study also examined dietary intakes of both mothers and children in pulse or cereal based agricultural communities using multiple dietary assessment tools. The results, only partially met the hypothesis that diets and nutritional status would be better for women and children in pulse growing communities. That is, despite the low consumption of animal source foods by mothers and children in the pulse growing communities reported here, dietary intakes were generally higher for mothers in pulse communities, though this was not the case for the children. The fact dietary intakes of pulse children were not as high compared with cereal children might indicate a gap in caring practices for young children. The existence of gaps in chid caring practices is supported by findings on poorer IYCF practices reported in a related study in Chapter 5 (Ersino, Henry, & Zello, 2016). Both mothers and children also had higher pulse consumption indices in the pulse growing communities, which was expected. Median energy intake of the pulse mothers, though significantly higher than those in the cereal group, was only 58% of the RNI (i.e., estimated energy intake), and this was reflected in the observed higher maternal undernutrition reported in Chapter 4. The poor nutritional status of the mothers in the pulse communities, despite the relatively better nutrient and energy intake, was perhaps due to the higher work-burden women experience in these communities. Though evidence on dietary intakes of non-pregnant women is limited, intakes of low median energy and nutrients (such Fe & Zn) have been reported among rural pregnant women that were mainly maize or Enset (starchy staple) based communities from southern Ethiopia (Abebe et al., 2008; Gibson et al., 2008).

Dietary diversity can be used as an important proxy indicator for micronutrient adequacy of both women's (FAO & Family Health International 360, 2016) and children's diets (WHO, 2008). Studies in Ethiopia and other developing countries have shown the association between maternal and child dietary diversity (Nguyen et al., 2013), as well as their association with stunting (Rah et al., 2010). The low dietary diversity scores and heavy dependence on a few staples from only one or two food groups reported here is also concerning. At least 75% of mothers and children from either group consumed only from ≤4 food groups out of nine main food groups, and consumption from animal source foods was minimal or almost negligible. The median scores for both mothers and children could have been <3 considering the fact that some of the food items (tomatoes, onions, green peppers…) for which a score of "1" was given were consumed more like spices and condiments than as main food items. The poor diet diversity scores among the women in both communities is even more concerning in light of the new recommendation of ≥5 food groups as the minimum dietary diversity for women (FAO & Family Health International 360, 2016). However, the finding here is not unique as this scenario has been previously reported by other studies and national reports (Abebe et al., 2008; CSA & ICF International, 2012; EHNRI, 2010; Ersino et al., 2013; Gibson et al., 2009; Gibson et al., 2008; Tessema et al., 2013).

Of note is that the proportion of pulse mothers/children consuming 'legumes, nuts and seeds' were not that large or significantly different compared with the cereal group. Though consumption indexes of pulses were significantly higher in pulse groups, the median score of 2 reflected consumption of pulses only once or twice/week. Despite the initial assumption that pulse communities should benefit from consumptions of the pulses or indirectly from the cash proceeds pulses generate, several factors might have contributed to the low consumption and overall poorer nutritional status in the pulse group. Indeed, most households (94%) in the pulse group produced some pulse crops; however, production was almost entirely controlled by men and the proportion of households where both men and women co-control pulse production was <3%. From an FGD with the farmers (result not presented), it was learned that much of the pulse crop was sold at market for the purchase of artificial fertilizer and some other staples like maize. The fact that only 20% of the pulse households used their 'own production' as their main source of pulses consumed at home–despite all being pulse producers, probably indicates that much of the pulses they produced were sold at market. The lack of knowledge on nutrition benefit of pulses and significantly lower positive attitude to pulse-foods might have played a role in the poor pulse consumption. The low consumption of pulse based foods in this area has also been previously reported among adolescent girls (Roba et al., 2015).

As pointed out earlier, the MCA also revealed other factors that contributed to the poor nutrition of mother-children in pulse or cereal groups (Table 7.5 & 7.6). Children of older mothers (35-49y), those children older than 24 months, children from pulse growing communities, and from households with smaller land size had worse mean HAZ scores after controlling for all other factors in the adjusted model. This could be due to the fact that older mothers, who had lower formal schooling (result not shown), may have had also lower nutrition literacy to provide appropriate care for their children; this is in agreement with reports of national surveys where lower maternal schooling is associated with higher stunting in children (CSA, 2014; CSA & ICF International, 2012). The fact older children were worse on their HAZ score may indicate the poor dietary and sanitary environment for young children, particularly after they stopped breastfeeding. Likewise, mothers with no access to land, with stunted children, <4 times antenatal visits, and with work-burden had significantly lower mean MUAC, indicating the importance of access to health/nutrition services and important resources such as land.

Many of the pulse-related and other factors (from regression analysis) that influenced poor consumption or nutritional status, particularly in the pulse group, could be improved through provision of basic nutrition education that also highlights the potential benefits of pulses so the community could take advantage of their pulse growing tradition. This may help pulse growing communities to consume pulses, especially as they have limited access to animal source foods, and also to utilize cash generated from pulse sales for the purchase of fruits and vegetables not grown in their communities. However, the education should also advocate priorities for mothers and children when it comes to food distribution in the household. Empowering women to increase their access to their own piece of land—where they could potentially grow food for home consumption—and also increasing their participation in decision making regarding pulse produce in the home, will have positive influence in improving the nutrition of their family and themselves. Minimizing the work burden of women by ensuring access to drinking water in close proximity is also another area that needs the government's attention. Empowering women by improving their access to land (Allendorf, 2007), increasing their livestock co-ownership/ownership (Jin & Iannotti, 2014) or ensuring income from employment or other sources (Negash et al., 2015) have been shown to have positive associations with improved child nutritional status.

Despite the fact pulses have been an integral part of the Ethiopian diet for many years (Ethiopian Export Promotion Agency, 2004), this study was one of the few that attempted to document evidence as to whether pulse-production translates to nutritional health in a comparative study design involving pulse or cereal-based communities. The study also examined dietary intakes and consumption patterns in most vulnerable groups using multiple dietary assessment tools. However, the study had the following limitation: consumption indexes of food groups were based on recalls of long time frame; though this did not affect the accuracy of frequently consumed foods, foods rarely consumed (such as flesh foods) might not have been reported accurately. Weighed food records were taken only for one day and hence, usual intakes of individuals or prevalence of risk of inadequacy of energy and nutrients were not estimated. Given the poor consumptions of fruits and vegetables, there may be more micronutrient deficiencies which were not analysed (partly because the focus here was on pulses and the nutrients they may affect the most). Additional studies in these areas may help strengthen the evidence on the nutrition/health and other benefits of pulses in resource poor rural Ethiopia.

7.5. Conclusion

Overall, dietary intake and consumption patterns of mothers and children appeared to be poor in both pulse and cereal communities. Lack of access to land and work-burden on women might have aggravated poor nutritional status in these communities. Though pulse mothers had higher levels of energy and nutrient intake, their children had a significantly lower intake compared with their cereal counterparts. In addition, the median energy intake of the mothers was much lower than estimated energy requirements in both pulse and cereal groups. Dietary diversity scores were low in both communities and the proportions in the pulse community that consumed pulse-based foods did not exceed those in the cereal community, though almost all pulse households reported growing pulses. The median pulse-consumption-index of the pulse community, though higher than the cereal, still indicated infrequent (once or twice/week) consumption of any pulses despite the poor consumption of animal source foods, indicating pulse production does not necessarily translate to consumption and associated nutritional benefits. Nutrition education in the pulse communities may improve consumption and potential nutritional benefits of pulses traditionally grown in the area. This community baseline study also indicates a need to strengthen nutrition service delivery programs to mothers-children.

Chapter 8 A nutrition education intervention positively affects the diet-health related practices and nutritional status of mothers and children in a pulse-growing community in Halaba, south Ethiopia (Study 5)

Abstract

A six-month nutrition education intervention on the consumption of pulses and other foods was conducted on mothers of children under 5 in the pulse-growing region of Halaba, south Ethiopia. The intervention incorporated the health belief model, on Knowledge, Attitude and Practices (KAP), and objective measures included dietary diversity scores (DDS), dietary intakes and nutritional status. Between March 2013 and April 2014, 200 mother-child pairs, randomly selected from each of two purposively selected communities, participated in a quasi-experimental intervention study. A six-month nutrition education program, involving interactive monthly community meetings and home-visits, was offered to one of the communities and the other served as a control. Demographics, KAP, food perceptions, DDS, and dietary and anthropometric information were collected at baseline and endline. Focus group discussions (FGD) with local farmers also occurred. Significant improvements in the intervention group were found from baseline to endline for KAP and perceptions of pulse nutrition benefits among mothers; DDS and pulse and animal source food consumption indexes for both mothers and children; and mean body-mass index-for-age (BMI-for-age) z-score and wasting among children. Farmers in the FDG also expressed improved intention to produce and retain more pulses for home consumption. No such changes were found in the comparison community. Community-based nutrition education interventions involving monthly interactive community meetings and home-visits in traditional pulse-growing communities could be effective in improving mothers' knowledge of pulse nutrition and consumption frequency. Such interventions may lead to increasing DDS in mothers and their children, and decreasing underweight and wasting among children in rural Ethiopia.

Keywords: Nutrition education intervention, maternal and child nutrition, dietary diversity, Knowledge, attitude, Practice, pulse consumption, Ethiopia

8.1. Introduction

Linking agriculture to nutrition and health has been strongly emphasized in recent years. Integrating nutrition education as part of a behaviour communication tool along with agricultural interventions has been reported to hold potential in improving nutrition of communities (World Bank, 2007). Agriculture interventions that focused on the production aspect only, with no or limited integration to nutritional outcomes, did not produce significant impact on the nutritional status of children (Masset et al., 2012; World Bank, 2007). Masset et al reviewed agricultural interventions in developing countries, from 1990 onwards, that specifically aimed at improving children's nutritional status, such as bio-fortification, home gardening, animal husbandry and poultry and fishery development. The review did not find significant effects of such interventions on the nutritional status of children, nor did it mention whether these interventions had strong nutrition education components. However, the investigators also cautioned that the lack of impact on nutritional status of children might have been due more to design issues than the absence of effects by the interventions themselves (Masset et al., 2012). As a result, the integration of behaviour-change communication tools such as community based nutrition education with agricultural interventions with strong designs[17] has been promoted to optimize and improve the effects of agriculture on nutrition.

Production of pulse crops is one area of agriculture that can be leveraged to improve nutrition of populations in pulse growing communities. Pulse crops are low fat legumes with up to twice the protein of cereals and are rich in minerals like iron and zinc (FAO & WHO, 2007; Ofuya & V., 2005; Pulse Canada, 2012). Pulses have certain inherent beneficial qualities, such as lowering blood cholesterol levels, managing blood sugar, and reducing obesity and cardiovascular diseases (Bouchenak & Lamri-Senhadji, 2013; Champ, 2002; Pulse Canada, 2016; Rebello, Greenway, & Finley, 2014; Rizkalla et al., 2002). They also have other multiple benefits including complementing cereal-based staple foods; contributing to food security as they are short-maturing and grow under low moisture conditions; generating cash income due to their higher market value than cereals; and serving as natural fertilizer due to their capacity to fix atmospheric nitrogen, hence lowering the costs of artificial fertilizer and contributing to a more sustainable environment.

[17] Such as intervention-control designs or controlled comparison of cross-sectional studies as opposed to pre-post comparison studies or studies with no control group.

Ethiopia is one of the countries where pulses are grown for both food and cash income (Ethiopian Export Promotion Agency, 2004). Pulses play an important role in the diet of Ethiopians by complementing cereal staples as frequent consumption of animal source protein is unaffordable to the rural poor (IFPRI, 2010). However, malnutrition among children and mothers in rural Ethiopia where over 80% the population resides, has remained at high levels despite gradual progress in the last decade (CSA, 2014; CSA & ICF International, 2012; CSA and ORC Marco, 2006).

Production of pulses could be geared toward improving diets in rural communities; however, intervention studies that focused on production and use of pulses to improve nutritional status are limited. Some studies in Ethiopia have shown that nutrition education interventions can be effective approaches to promoting awareness, knowledge and skills in household pulse food preparation (Mulualem et al., 2016; Negash et al., 2014). Participatory pulse agriculture-nutrition intervention research in rural communities of northern Malawi has also been shown to improve child undernutrition (Bezner Kerr et al., 2011). The study in northern Malawi lasted for about eight years and included several villages that were involved in pulse intercropping and nutrition education. The nutrition education also included child feeding practices and gender relation—household decision making on pulse use through monthly, small group discussion meetings (Bezner Kerr et al., 2011). A cross-sectional study of adolescent girls in Halaba, a pulse-growing district in south Ethiopia, reported high undernutrition but infrequent consumption of pulses that had limited contribution to protein and iron intakes of the girls (Roba et al., 2015). The study speculated that a nutrition education focusing on potential barriers and benefits of pulses may improve frequency of consumption and provide nutrition benefits.

Our baseline studies in Halaba, conducted as part of a pre-intervention study, had shown high prevalence of maternal and child undernutrition, limited consumption pulses, low dietary diversity and low overall dietary intakes (Lombamo, Henry, Regassa, & Zello, 2016; Lombamo, Henry, & Zello, 2015). Analysis of health behaviours of mothers based on the Health Belief Model (HBM) constructs of perceived susceptibility and severity to risk of malnutrition, as well as perceived benefits of pulses and barriers to their consumption, was done in pulse and cereal-growing communities (Ersino, Zello, & Henry, 2015). The results showed that mothers from the pulse-communities perceived greater barriers to pulse consumption but had lower perceived scores on severity of child malnutrition compared with mother from cereal-growing communities. The use of theories to guide nutrition interventions promoting a particular health behaviour has been shown to be more effective than those with no theoretical foundation (Contento, 2011; Glanz et al., 2008). The HBM, one of the earliest and most widely used theoretical models of behaviour, theorizes that people's perceptions of the threat posed by a certain health behavior or practice and their perception of the benefits of and barriers to the proposed behaviour determine their readiness to take the proposed behaviour or action (Contento, 2011; Glanz et al., 2008). The HBM principles have been effectively used to guide nutrition education interventions to improve complementary feeding practices of mothers in similar settings elsewhere in southern Ethiopia (Mulualem et al., 2016; Tariku, Whiting, Mulualem, & Singh, 2015).

The current study aimed to measure the effect of a nutrition education intervention that focusing on pulse production and consumption on the knowledge, attitudes, practices and nutrition of mothers and children in two leading pulse growing communities from rural Halaba, south Ethiopia. The communities were purposefully selected by consulting the local agriculture office based on their pulse production records. Based on the baseline studies, a six-month educational nutrition intervention that incorporated the principles of the Health Belief Model was designed and implemented in one of the two communities, while the other acted as a control. We emphasized multiple benefits of pulses as a way to tackle the perceived barriers to consumptions.

8.2. Methods

8.2.1. Study setting, participants and design

This quasi-experimental intervention study was conducted in two rural communities of Halaba Woreda/district, known traditionally as the pulse and pepper producer. The Woreda is located in the southern parts of Ethiopia and is administratively affiliated with SNNPR. The two rural communities considered for this intervention study were selected based on the recommendation of the local agriculture office for their leading role in pulse production (mostly red kidney beans) in the district. The local names of the two communities are *Guba-Sherero* and *Holagoba-Kukie*. Additional descriptions of the study areas can be found in previous chapters.

Mothers, along with their youngest child <5y of age, were considered for the study. About 200 mother-child pairs were randomly selected from each of the two communities. The sample size was initially determined for the baseline study using a formula for a cross-sectional study (Charan & Biswas, 2013). Households in the study communities where there was a mother with a child under 5y of age were eligible for the study. In addition to the mothers and their children, a group of local male farmers from each community (with good knowledge of their local community) were included in the study for a Focus Group Discussion (FGD) before and after the planned intervention. Though the main targets of the intervention were women, male farmers were also targeted through the local agricultural extension worker, who had been trained as part of the nutrition education team. Hence, it was fitting to obtain some feedback from the farmers in the form of an FDG. Ethics clearance was obtained from the Behavioural Ethics Board (BEH#12-357) of the University of Saskatchewan, as well as the Regional Health Bureau of SNNPR. All mothers also gave oral consent after the purpose and details of the research activity had been read and explained to them by the local research assistant. The study was conducted between March 2013 and April 2014.

Following a baseline study, the two communities were assigned to be either an intervention or comparison community in a quasi-experimental design. Based on results from the baseline study, one of the communities (i.e., *Holagoba-Kukie),* which had higher prevalence of child stunting and maternal undernutrition, was purposely assigned to receive the intervention with the intention it might benefit the most from the planned educational intervention. Hence, the other pulse growing community (*Guba-Sherero*) became the comparison community instead of a control due to the baseline differences in the main outcome variables. The two communities, though in the same district, were not adjacent to each other and were far enough to minimize potential contamination of the education intervention to the unintended community. Studies suggest that contamination is least when clusters/groups are physically and socially separated (Keogh-Brown et al., 2007).

8.2.2. The intervention

An educational nutrition intervention was given to the intervention community for six consecutive months following the baseline data collection and preliminary analysis. The preliminary analysis of the baseline information helped inform the education intervention from the selection of the community with higher maternal-child undernutrition to content of the education and setting, as well as overall delivery strategies. The education intervention aimed at promoting pulses and pulse-based foods as part of healthy meals, along with promotion of other food groups in a pulse growing rural community. The education mainly targeted mothers participating in the study; Husbands, other member of the household and the general public were also encouraged to participate with the intention to create a supportive environment for the mothers to apply the new information.

The education was offered by two trained nutrition educators, along with two local health extension workers and one agriculture extension worker in the intervention community. The two nutrition educators (a B.Sc. nutrition graduate and a diploma nurse) were part of the baseline data collection team and accustomed to the intervention community. The health and agriculture extension workers helped deliver the nutrition education during their routine contact with the mothers or male farmers in the community. In addition to the three-day training offered for the baseline data collection, the nutrition educators received one-day training session by the principal investigator on the content and delivery of the education intervention. The nutrition graduate supervised the implementation of the nutrition education at the field level and also helped with delivering the education during home visits and monthly discussion meetings, as described below.

The intervention had six monthly group sessions, as well as one or two monthly home visits to individual households. Participant mothers from the community came to a central location (the local Health Post, in this case) once every month for six months to converse on the topic for the particular month. Following the group sessions at the beginning of each month, the educators visited each household before the monthly session, conversed with mothers on the topic for that month and allowed mothers to ask any questions they had on the topic and related areas. At the start of each new intervention-month, topics covered previously were reviewed through questions and answers. By the end of the six-month intervention, each participating mother had received at least one home visit each month for six months, in addition to participation in the monthly group sessions, which also occurred for six months.

The education contained six basic nutrition and related topics for each month framed based on previous studies and baseline findings. A summary of the topics, content highlights, and key nutrition messages are presented in Table 8.1. The educators were given a laminated smaller size color print poster to aid the discussions on each of the six topics. They also had larger versions of the poster for the monthly group session. In addition, educators were given a copy of a small booklet, the facilitator guide prepared for the intervention, to help them facilitate

Table 8.1 Summary of the nutrition education topics, content highlights and key messages

Session	Topics	Content highlights	Key nutrition messages	Duration
1	Tips on nutrition during pregnancy, lactation early childhood.	• Importance of healthy eating before and during pregnancy and lactation for the health of both the mother and children; • Understanding the increased nutritional needs of mothers and growing children and hence prioritizing them during intra-household food distribution;	→Prioritise the nutrition of pregnant & lactating mothers and also children. Mothers and children should be given priority in the intra household food distribution.	45 min-1 hr
2	Food groups & diversifying diets	• Understanding the concept of food groups and diversifying diet	→A healthy meal/diet is one that includes variety of foods from the different food groups.	45 min-1 hr
3	Improving protein quality of cereal-based foods with pulses	• Important contribution of pulses as good sources of protein and micronutrient, and • how protein quality of cereals can be improved by combining them with pulses crops;	→Combining foods from cereals with pulses (e.g. kidney beans) makes a good quality protein (complete protein).	45 min-1 hr
4	Consumption of fruits & vegetables	• Understanding the importance of including fruits and vegetables in the diet	→Fruits and vegetables are excellent sources of nutrients that help our body to fight off disease/sickness.	45 min-1 hr
5	Benefits of pulses	• Benefits of pulse agriculture in improving soil fertility, saving the money for other household needs which would otherwise be spent for purchase of artificial fertilizer; • Source of cash income through selling of pulses as they are high value crops;	→Pulses are nutritious, good for health and contribute to healthy environment by making their won natural fertilizer.	45 min-1 hr
6	Sanitation/hygiene	• Basics of personal and environmental hygiene, • Hygiene during child feeding (breastfeeding and complementary feeding) practices;	→Maintain a healthy environment for children by keeping your homestead clean and handling food hygienically, practicing hand washing as often as possible.	45 min-1 hr

the sessions over the six months. The guide contains a brief introduction on the topic, an interactive learning activity, notes of the educators, key messages and closing remarks. Details of the intervention and the guide can be found in Appendices A and B, respectively.

8.2.3. Data collection, tools and analysis

Both qualitative and quantitative data were collected. A questionnaire and an interview guide were used to interview the mothers and men farmers (in the focus group discussion), respectively. The questionnaire contained sections on background information; mothers' nutrition/pulse related knowledge, attitude and practice; dietary diversity and food frequency questions (pulse and food groups); and nutrition/pulse related questions based on the six constructs of the health belief model (HBM) (18 questions, three for each of the six constructs). Details on the tools used have been described in Chapter 3.

Following standard procedure and tools, anthropometric measurements (height in centimeters, weight in kilograms, mid-upper arm circumference in centimeters) were taken for mother-child pairs, both at baseline and post-intervention. One-day weighed food record data were also collected in a subsample of the study population. Details of the tool and the data collection processes have been described in the general methodology and subsequent chapters.

All questionnaire-based data and weighed food records were collected by trained female data collectors, supervised at the field level by the student researcher and BSc nutrition graduate research assistants. Data interviews were carried out at the residences of participants or at the nearest local community centres (schools, health centres or health posts). To minimize measurer error, one anthropometrist (the principal researcher) carried out all anthropometric measurements, both at baseline and end line, at the nearest community centres. The principal researcher, assisted by research assistants, also conducted the focus group discussions at each community before and after intervention.

All questionnaire based data were entered in SPSS spreadsheets (SPSS Statistics Version 20, IBM Corp., Armonk, NY, USA). WHO Anthro (ver. 3.2.2) 2011 was used to analyse and convert anthropometric measurements of the children into height-for-age, weight-for-height, weight-for-age and BMI-for-age Z scores, which were then transferred to SPSS spreadsheets for further analysis. Results are presented using descriptive statistics such as means (±SD), median (1^{st}, 3^{rd} quartiles) and percentages. Tests used include the paired-sample *t*-test for means, the McNemar test for prevalence estimates in the within group analysis; the independent sample t-test for means and the chi-square test for prevalence estimates in the between group analysis; Mann Whitney *U* and Wilcoxon's tests were also used for the non-parametric tests of between and within group analysis, respectively. Statistical significance was generally set at $p < 0.05$. Insights and conversations from the FDGs were summarized in themes following the main questions asked on the interview guide. Direct quotations were also included from the FGD participants, who reflected on what they thought were gains from the six-month intervention.

8.3. Results

Results have been summarized only for participants from households that completed both the baseline and end line study. They slightly vary across the different assessments but generally were about 90% of those that completed the various assessments at baseline at each community. Brief individual and household characteristics of these participants in the comparison and intervention communities are presented in Table 8.2. Median household size, maternal age, wealth index, as well as mothers' and their husbands' formal education status were similar

Table 8.2 Summary of background characteristics of participants from two pulse producing communities in rural Halaba, Ethiopia, 2013-2014

Background characteristics	Comparison community	Intervention community
Median (25^{th}-75^{th})	n= 180	n= 183
Maternal age (y.)	27 (25-30)	29 (25-32)
Household size	6 (4-7)	6 (4-7)
Wealth index	5 (3-8)	5 (3-7.6)
Size of cultivable land (ha)	1 (0.5-1.5)	0.75 (0.5-1) [a]
Pulse produce from recent harvest (quintals)[1]	3(2-4)	2 (1.88-3) [a]
Number of under 5 children (%)		
One	43.9	69.4
Two or more	56.1	30.6
Maternal formal education status (%)		
No formal education	77.8	82.5
Primary or above	22.2	17.5
Husbands' formal education status (%)		
No formal education	55	53.6
Primary level (1-6 grades)	32.2	30.1
Post primary (>6^{th} grade)	12.3	16.4
Pulse crop growing status		
Yes	89.4	100

[1] Estimate was based on only 150 households in each community that declared amount of pulse produce for their household; [a] Difference was significant at $p < 0.001$ (*Mann-Whitney U test*);

between the comparison and intervention communities. The size of cultivable land and the amount of pulse crop produced (during the most recent harvest season preceding the study) appear to be slightly better for the comparison than the intervention community ($p < 0.001$). Nearly twice as many as households in the comparison community as the intervention had two or more children under five years of age. The majority or all households in either community identified themselves as pulse growers.

8.3.1. Knowledge, attitude and practice (KAP)

Table 8.3 presents information on KAP of mothers on overall nutrition or pulse production and consumption in the intervention design. There were no significant differences in the reported 'knowledge of balanced diet' and knowledge of 'nutritional benefits of pulses' at baseline between the groups. The knowledge of these two items improved significantly both within groups and between groups following the intervention ($p < 0.01$), and improvement was significantly better for the intervention than the comparison group ($p < 0.01$).

Table 8.3 Nutrition-pulse related knowledge, attitude and practice of mothers from two pulse growing rural communities of Halaba in quasi-experimental design, 2013-2014, Ethiopia

	Comparison community		Intervention community	
	(Pre), n=182	(Post), n=182	(Pre), n=184	(Post), n=184
Mothers' knowledge of balanced/varied diet	29.1	44.5	22.8	90.8 [a, b]
Use of pulses both for home & market (income)[n]	74.7 [b]	88.4	73.9	95.1 [b, c]
Consumption of pulse/foods from pulse by mother-child	84.1 [a, b]	98.9	98.4	100
Positive attitude toward pulse-based foods	72 [a, b]	85.2	82.6	99.5 [a, b]
Knowledge of nutritional benefit of pulses	45.1 [b]	72	37.5	98.4 [a, b]
Intention to consume more pulse or pulse-based food in the future	59.9 [a]	81.3	76.1	98.4 [a, *b*]

[a] significant at $p < 0.01$ between respective groups (*Chi-square test*); [b] significant at $p < 0.01$ within respective groups (*McNemar test*); [c] P=0.051 between respective groups (*Chi-square test*); [n] sample size of the comparison group for this variable is 161;

Use of pulses for both home and market (income) purposes has improved in both groups following the intervention ($p < 0.01$), and improvement was better in the intervention group ($p < 0.01$). Reported consumption of pulses or pulse-based foods by mothers and their children was already high at baseline in both groups, particularly in the intervention ($p < 0.01$). Following the intervention, responses to this item remained high in the intervention group while it also significantly improved in the comparison group ($p < 0.01$). The mothers' positive attitude toward pulse-based foods was already higher at baseline in the intervention group ($p < 0.01$) and remained even higher following the intervention ($p < 0.01$). Within group improvements were also significant ($p < 0.01$) and of similar magnitude in both groups following the intervention.

8.3.2. Frequency of consumption index and selected food groups and diet diversity

Table 8.4 presents mothers' and children's frequency of consumption from certain food groups, summarized as consumption indexes, as well as median dietary diversity scores with

Table 8.4 Consumption index and diet diversity scores [median (25th-75th)] for mother and children from two leading pulse growing rural communities of Halaba in quasi-experimental design, South Ethiopia, 2013-2014

	Comparison community		Intervention community	
	Pre	Post	Pre	Post
Mothers consumption index	n=180	n=180	n=185	n=185
Any animal product	1.3 (1-1.8)	1.3 (1-1.8)	1.3 (1-1.5)	1.5 (1-1.8) [a]
Any fruits or vegetables	2.5 (2-3) ***	2.5 (2-3)	2.5 (2.5-3)	2.5 (2.3-3)
Any pulse *(lentil, peas, kidney beans, broad beans)*	2 (1.5-2.3) ***	2 (1.8-2.8) [a]	2.3 (1.8-2.5)	2.3 (2-2.8) [a]
DDS	4 (3-4) ***	3 (3-4) [a]	3 (3-4)	[a]4 (3-4)
Children (6-59 months) consumption index	n=113	n =113	n =126	n=126
Any animal product	1.3 (1-1.8)	1.5 (1-1.8)	1.3 (1.3-1.8)	1.5 (1.3-2) [a]
Any fruits or vegetables	2.5 (1.5-3) ***	2.5 (2-3)	3 (2.5-3)	3 (2.5-3)
Any pulse *(lentil, peas, kidney beans, broad beans)*	1.8 (1.5-2.3) ***	2 (1.5-2.5) [a]	2.3 (1.8-2.6)	2.3 (2-2.8) [a]
DDS	3 (2.3-4)	3 (3-4) [a]	3 (3-4)	4 (3-4) [a]

***significant at $p < 0.001$ (*Mann-Whitney U*, 2-tailed) between groups; [a] estimates significantly different at $p < 0.05$ (Wilcoxon, 2 tailed) within groups (Differences in DDS & pulse consumption index of mothers among the comparison group were very significant at $p < 0.001$); Consumption index: 1=least frequent (≤ 2 per month), 2= 1-2 times per week, 3= 3-6 times per week, 4=most frequent (≥1 per day);

25^{th}-75^{th} percentile values. Accordingly, the consumption index of mothers for animal source food did not differ at baseline between groups, but it significantly improved in the intervention group following the intervention (p <0.05) while it remained unchanged in the comparison group. The consumption index of fruit and vegetables for mothers was slightly different at baseline between groups but did not differ within or between groups following the intervention. The pulse consumption index of mothers was better for the intervention community at baseline compared with the comparison community (p < 0.001); at end line, mothers in both groups improved their consumption index of pulses (p < 0.001), but there is no significant difference between groups.

The diet diversity of mothers in the intervention community was significantly lower at baseline compared with the comparison (p < 0.05), but it significantly improved for the intervention group at the endline while it significantly dropped for the comparison community (p < 0.05).

Similarly, the consumption index of animal source foods for children was similar for both groups at baseline but significantly improved in the intervention group following the intervention (p < 0.05), while it remained unchanged in the comparison community. The fruit and vegetable consumption index of the children was also already better at baseline for the intervention group (p < 0.001) and remained high at end line as well, even though this did not significantly differ between or within groups. The pulse consumption index was significantly better at baseline for the intervention group (p < 0.001), and the index improved significantly within groups following the intervention (p < 0.05);

The median diet diversity scores for the children were similar at baseline but both communities had improved diet diversity, though it was not significant between groups following the intervention.

8.3.3. Averages scores based on the constructs of the HBM

Average scores on perceived susceptibility and severity to consequences of poor dietary practices; scores on perceived benefits of pulses and barriers to their consumption, as well as scores on cues for consumption of pulses and self-efficacy (of mothers to take steps to healthier dietary practices) significantly improved following the intervention in both groups, but improvements were significantly higher ($p < 0.001$) for the intervention compared with the comparison group (Table 8.5).

Perceived benefit of pulses did not significantly improve in the comparison community, while it did in the intervention group ($p < 0.001$). While the average scores for perceived barriers to consumption of pulses were not significantly different at baseline, they dropped significantly in both groups following the intervention, but the drop was almost twice as high in the intervention as it was in the comparison group ($p < 0.001$).

Table 8.5 Mean (± SD) scores of mothers on the six main HBM domains in the intervention design from two pulse growing communities of rural Halaba, southern Ethiopia (2013-2014)

	Comparison community		Intervention community	
HBM main domain Items	(Pre.), n=180	(Post.), n=180	(Pre.), n=185	(Post), n=185
Perceived susceptibility to consequences of poor dietary practices	3.41 (0.86) **	3.68 (0.55)	3.68 (0.97)	3.88 (0.48) ***
Perceived severity of consequences of poor dietary practices	3.15 (0.81) **	3.59 (0.55)	3.4 (0.86)	3.79 (0.57) ***
Perceived benefits of pulses	3.42 (0.76) **	3.51 (0.62)	3.63 (0.72)	3.91 (0.54) ***
Perceived barriers to consumption of pulses	2.71 (0.95) [a]	2.22 (0.62)	2.72 (0.91)	1.86 (0.51) ***
Cues for consumption of pulses	3.32 (0.84) **	3.59 (0.72)	3.9 (0.74)	4.14 (0.37) ***
Self-efficacy (of mothers to take healthy steps to dietary practices)	3.1 (0.91) **	3.71 (0.66)	3.36 (0.8)	4.04 (0.29) ***

**Difference significant at $p < 0.01$ between respective group (independent-samples *t* test, equal variance not assumed) and within group, except *'perceived benefit'* (paired-samples *t* test, equal variance not assumed); ***difference significant at $p < 0.001$ between respective group (independent-samples *t* test, equal variance not assumed) and within group (paired-samples *t* test, equal variance not assumed); [a] significant at $p < 0.001$ within group only (paired-sample *t* test, equal variance not assumed);

8.3.4. Maternal and child anthropometry

A summary of anthropometric measurements and associated indices is presented in Table 8.6 for both intervention and comparison groups. There were no significant differences between groups in mean height, MUAC, weight and BMI of mothers both at baseline and post-intervention in either group. Levels of undernutrition in mothers (%BMI < 18kg/m^2) slightly dropped in the comparison community in the post-intervention study but remained the same in the intervention group. Differences were not significant between or within groups both at baseline and post intervention period. Based on classification for public health significance, the prevalence of low BMI (i.e., % BMI <18.5kg/m^2) remained of medium concern in the comparison community, whereas it was high in the intervention community after the completion of the 6 months of nutrition education intervention.

Table 8.6 Results from anthropometric measurements and associated indices for mothers and children from pulse growing rural communities in Halaba in the intervention design, Ethiopia, 2013-2014

	Comparison community		Intervention	
Mothers	Pre (n=161)	Post (n= 161)	Pre (n=165)	Post (n=165)
Mean (±SD)				
Height (cm)	158 (6)	158 (6)	156 (5)	156 (5)
MUAC (cm)	25 (3)	25 (3)	24 (2)	24 (2)
	n=136	n=136	n=137	n=137
[a] Weight (kg)	52 (7)	52 (7)	48.7 (5.4)	49 (5.3)
[a] BMI (kgm^{-2})	21 (2.4)	20.8 (2.3)	19.9 (1.8)	20 (2)
[a] BMI (kg/m^2) categories (%)				
Underweight (<18.5)	18.4	12.5	23.4	24.8
Normal range (18.5-24.99)	76.5	83.1	76.6	73.7
Overweight (25-29.99)	5.1	4.4	0	1.5
Children (0-59.99 months of age)	n=164	n=164	n=162	n=162
Mean (±SD) z-scores				
Height-for-age	-1.87 (1.7) [*, b]	-2.24 (1.3)	-2.24 (1.4)	-2.53 (1.16) [*, c]
Weight-for-height	-0.47 (1.3) [*]	-0.29 (1.04)	-0.55 (1.22)	-0.47 (1)
Weight-for-age	-1.43 (1.48)	-1.42 (1.17)	-1.69 (1.35)	-1.71 (1.1) [c]
BMI-for-age	0.35 (1.23) [*]	0.03 (1.03)	-0.42 (1.22)	-0.13 (1.02) [*]
Prevalence (%)				
Stunting	45.7 [*, b]	54.3	59.3	67.9 [c *]
Wasting	11 [*]	3.7	11.1	4.9 [*]
Underweight	30.9	30.9	42.3	36.2

[a] Excludes pregnant mothers, pregnant and lactating mothers and mothers who had babies with in the last two months prior to the anthropometric measurement; [*]significant at $p < 0.05$ within respective groups (*paired-sample t-test for the 'mean z-scores', and McNemar test for prevalence estimates*); [b] significant at $p < 0.05$ between respective groups (*independent sample t-test for the mean z-scores and Person Chi-square test* for prevalence estimates); [c] significant at $p < 0.05$ between groups (*independent sample t-test for the mean z-scores and Person Chi-square test* for prevalence estimates);

The mean HAZ of the children significantly dropped (worsened) in both the intervention and comparison community ($p < 0.05$), but the magnitude of the change in the drop was greater in the comparison (-0.37) than in the intervention (-0.29) community. The mean BMI-for-age of the children in the comparison group significantly decreased, whereas it increased significantly in the intervention community ($p < 0.05$). Mean WAZ did not change significantly within groups before and after the intervention, but it was significantly lower (worse) in the intervention group in the post intervention study compared with the comparison ($p < 0.05$).

Similarly, prevalence of stunting significantly increased in both the comparison and intervention community following the 6 months of intervention, and it was worse in the intervention group both at baseline and end line ($p < 0.05$). In contrast, prevalence of wasting declined significantly in both groups following the intervention ($p < 0.05$); however, there was no significant difference in rates of wasting between the groups before or after the intervention. Prevalence of underweight remained unchanged within groups even though it appeared to drop slightly in the intervention community. There was also no significant difference between groups following the intervention.

8.3.5. Average intakes of energy and selected nutrients

Table 8.7 shows the summary of group intakes of energy and selected nutrients in the intervention study in a subsample of study participants. The median energy intake of mothers was slightly above 50% of the RNI. There was no significant difference between or within groups following the intervention. However, mothers in the intervention community had slightly higher median value' for energy compared with those in the comparison community at baseline ($p < 005$). Medina intakes of protein for the mothers were above the RNI both at baseline and end line, and did not significantly differ between or within groups after the six-month intervention. Again median protein intake at baseline was higher for the intervention than the comparison group ($p < 0.05$).

Iron intakes of mothers, which were similar in both groups at baseline, improved significantly in the comparison ($p < 0.01$) as well as in the intervention ($p < 0.05$) group at end line, but these did not differ between groups. Zinc intakes did not change significantly both at baseline or end line in the within or between group design. Calcium, though similar at baseline, dropped significantly for intervention group both in the within and between group design ($p < 0.05$).

Table 8.7 Median (25th-75th) intakes of energy and selected nutrients from one day weighed food record data in a subsample of mothers and their children in pulse growing communities in Halaba, Ethiopia, 2013-2014

	Comparison community		Intervention community	
Mothers	Pre (n=63)	Post (n=63)	Pre (n=59)	Post (n=59)
Energy (Kcal) [#]	1410 (1128-1929)	1615 (1314-1892)	1669 (1431-1959) [a]	1711 (1469-2011)
RNI	2700	2700	2700	2700
% RNI	52	60	62	63.4
Protein (g)	53 (41-63)	57 (46-67)	61 (53-69) [a]	57 (46-66)
RNI	42	42	42	42
% RNI	126	136	145	136
Iron (mg)	60 (42-73)	70 (50-111) **	66 (51-87)	74 (50-169) *
RNI	58.8	58.8	58.8	58.8
% RNI	102	119	112	126
Zinc (mg)	13 (9-15)	13 (10-16)	14 (11-17)	13 (10-16)
RNI	9.8	9.8	9.8	9.8
% RNI	133	133	143	133
Calcium(mg)	758 (514-1140)	841 (635-1069)	983 (588-1178)	709 (564-988) * [b]
RNI	1000	1000	1000	1000
% RNI	76	84	98	71
Children (6-59 months)				
Energy (Kcal)	315 (184-545)	569 (423-790) ***	426 (256-614)	608 (488-783) ***
RNI	-	-	-	-
Protein (g)	12 (7-19)	18 (14-27) ***	16 (11-23)	20 (16-25) **
RNI	10-17	10-17	10-17	10-17
Iron (mg)	11 (6-26)	23 (16-46) ***	18 (12-30) [a]	29 (21-60) *** [b]
RNI	18.6-12.6	18.6-12.6	18.6-12.6	18.6-12.6
Zinc (mg)	2.8 (1.5-4.6)	4.3 (3.3-6.1) ***	3.4 (2.3, 5)	4.9 (3.3-6.2) ***
RNI	8.4-9.6	8.4-9.6	8.4-9.6	8.4-9.6
Calcium(mg)	167 (82-338)	298 (186-404) **	230 (141-364)	330 (215-439) *
RNI	400-600	400-600	400-600	400-600

[#]The daily recommendation of 2700 kcal chosen from FAO/WHO/UNU joint expert consultation report for human energy requirement (FAO/WHO/UNU, 2004) and assumes, an average weigh of 50kg and a physical activity level of 2.2 (the median for vigorous or vigorously active lifestyle) for rural mothers; ***, **, * significant within groups at $p < 0.001$, $p < 0.01$, and $p < 0.05$, respectively *(Wilcoxon test, non-parametric)*; [a] significant at $p < 0.05$ between groups at baseline *(Mann Whitney U test)*; [b] significant at $p < 0.05$ between groups at end line *(Mann Whitney U test)*; RNI, Recommended Nutrient Intake: assumes 5% bioavailability for iron & low bioavailability for zinc, based on WHO/FAO recommendations (WHO/FAO, 2004AO 2004). RNI values for protein are based on WHO/FAO/UNU recommendations (WHO/FAO/UNU, 2007AO) and were adjusted by average weight for the mothers;

Energy, protein, zinc and calcium intakes for the children were similar at baseline but increased significantly in both groups following the 6-month intervention ($p < 0.001$), and end line values were not significantly different between child groups. Iron intakes increased significantly in both groups following the intervention ($p < 0.001$) and were also significantly different at baseline ($p < 0.05$).

8.3.6. Qualitative results from Focus Group Discussions (FGD)

Qualitative results at baseline and end line based on conversations with the local male farmers—mostly elders and influential people—from both communities revealed what the community thought of the education. The participants of the FDG in the intervention group reflected on what they thought were the changes as a result of the intervention.

Most common food crops, including pulses, grown in the area - During the baseline discussion, FGD participants unanimously indicated that maize, bean, millet, teff, sorghum and pepper were the main crops grown in the area. However, the farmers also indicated that they almost entirely rely on maize and millets as their staple food: "Millet and maize are our main (staple) foods...teff and beans, we grow them but they are mainly for market/income purpose…" Participants also added that the reason they were not consuming beans and teff as often or as much as the other crops was because they had other pressing problems: "... (about beans and teff), well we would love to consume them at home but because we have other pressing problems, most of us sell our beans and teff." When asked which pulses were most commonly grown in their communities, farmers pointed out that the red kidney beans (also known locally as '*Nasir'* or *'Dimtu'* varieties) were the predominant pulse grown in the area. The farmers also said they used to grow white haricot beans, which they thought were good as food for children, but were no longer grown except by very few farmers. The main reason was the declining market demand for white haricot beans.

Following the intervention, however, farmers affirmed that they had since gained new knowledge about the multiple benefits of pulses and that they were considering growing more pulses than just kidney beans; one farmers stated, "After we got the education, we did not have much time to grow more pulses, but I tried to grow a handful of chickpeas and also lentils which is now serving me and my family in this post-harvest season…" According to participants, this was possible because the growing season for chickpea and lentil was different from that of kidney beans. Another farmer added "…I also grew lentils in a small plot of land. The plot was small but the benefit I am getting is high."

Farmers' thoughts on the benefits of pulses - Farmers indicated cash income from sale of beans as the main benefit and some said "it is good for our health'' and others still said, "it helps prevent diseases." Besides these, the farmers were not able to specifically mention the nutrition or other benefits of pulses. During the post intervention discussion, the farmers appeared to have better awareness about the benefits of pulse and were able to mention specific use of pulses: "We did not know that when kidney beans were milled together with other cereal (millet/sorghum…) that it substitutes meat. In our area, it is a little hard to afford meat. So this is why we intend to produce more so we could substitute meat." Another participant said the following: "… after your visits to our community, we have gained more knowledge about pulses (at least myself and my family) … If I should be honest, in the past, all of us were so eager to bring pulses to market, never for home consumption…", adding that despite the fact their community grew pulses twice a year, they were seldom interested in using pulses for home consumption. The farmers also recognized the role pulses play in improving soil fertility despite the old way of thinking that pulses/millets 'dry up' the soil making it unsuitable for growing other crops in the subsequent season.

The farmers also gave testimonials based on their observation of the women in their community regarding pulses: "Nowadays, our women are beginning to prevent us from bringing our pulses out to the market; why? Because they now know the benefits of beans. In the past, our women had little interest in beans except when they were making some snack out of it while the beans were still young/green; once it dried up, they had no interest in it; so we just sold it. But now, because of the increased awareness about benefits of pulses in our community, the women are claiming the pulses for home consumption."

Intentions of farmers to grow more pulses in the future - When asked if they (farmers) intend to increase production of pulses, the group unanimously indicated that it is indeed their intention to produce more pulses so they could take advantage of the many benefits they were taught pulses provide. In line with this, one participant reflected by saying "we have no intention to stop growing beans, in fact next month is the time to sow kidney beans and we are waiting for it."

Discussions with a similar farmer group in the comparison community during the baseline study were similar to those in the intervention community but did not yield such positive reaction during the post intervention FGD, although there was a general tendency to make positive changes toward pulse consumption or the overall nutrition situation in their community.

8.4. Discussion

Following the six-month nutrition education intervention, findings of this study indicated that mothers' knowledge of balanced diets and the nutritional benefit of pulses significantly improved in the intervention community. Reported consumption, and intentions to consume pulses or pulse-based foods, as well as positive attitudes toward pulse foods have improved significantly in both groups. The consumption index for animal source foods improved for mother-children in the intervention group after the six-months education, but no change was observed in the comparison community. Median dietary diversity scores (DDS) dropped for comparison community mothers, but significantly improved for those in the intervention community. Median DDS of intervention children also improved following the education; although overall DDS improved for comparison children, the median remained unchanged.

The nutrition education implemented in this study was very basic and tailored to the specific community, i.e., a pulse-growing rural community with low nutrition literacy. In addition to educating the community on key nutrition specific issues, the intervention emphasized nutritional benefits of including pulses as part of healthy family meals, as well as other benefits of pulses–i.e., what the households would gain if they followed through with the messages. Positive or 'Gain-framed' messaging, as opposed negative or 'loss-framed' messaging, has been indicated to be effective, particularly in individuals/communities with limited knowledge of the subject matter (Wansink & Pope, 2015). Negative messaging of health education has also been shown to be effective in bringing behaviour change but only among educated populous and if the negative message was strong enough to be perceived as a greater threat (Van 't Riet, Ruiter, Werrij, & De Vries, 2009). However, in the current study only positive messaging, such as the benefits of consuming pulses and a variety of foods from different food groups to mothers and children's health was encouraged. This was particularly important as the principal targets of the intervention were women, the majority of whom had not gone through formal schooling.

The “old model”—expert driven—nutrition education method, which was mere information transfer from experts to an audience, is no longer considered effective (Muehlhoff & Sherman, 2016). Instead, participatory approaches involving the target population in the planning, implementation and evaluation process have been suggested to be more effective in achieving the desired change and with increased chance of sustainability (Shediac-Rizkallah & Bone, 1998). The current intervention study applied a number of principles of participatory research including: conducting a formatting research (baseline assessment) to understand the nutrition related issues specific to the study communities; selection of nutrition/related tropics and formulating the content based on the formative research, including focus group discussions with local farmers and key informants (community leaders & elders); implementing the education led by trained local people from the community; allowing experience sharing and discussion by local mothers during the monthly sessions and home visits; and involving other household members (husbands, extended family members) and neighbours. Community-based education programs in northern Malawi involving various household members, such as grandmothers, and discussing multiple issues (such as gender, feeding practices), have showed positive effects in improving child feeding practices (Bezner Kerr, Dakishoni, Shumba, Msachi, & Chirwa, 2008; Satzinger, Bezner Kerr, & Shumba, 2009).

Dietary diversity scores have been used as proxy measures of both household’s socio-economic ability to access certain foods and the quality and micronutrient adequacy of diets consumed by individuals such as women and children (Kennedy et al., 2011; Swindale & Paula, 2006). The baseline results, as well as other studies in developing countries, have shown an association between maternal and child DDS (Lombamo et al., 2015; Nguyen et al., 2013); DDS has also been associated with maternal undernutrition and child stunting (McDonald et al., 2015; Rah et al., 2010). The lack of adequate dietary diversity among various subsistence farming household members, particularly children, has been reported by several studies in Ethiopia (Abebe et al., 2008; EHNRI, 2010; Gibson et al., 2009; Kedir Teji Roba, O’Connor, Belachew, & O’Brien, 2016; Mesfin et al., 2016; Tessema et al., 2013). The six-month educational intervention significantly improved dietary diversity in both mothers and children of the intervention community (Table 8.4); the increment of DDS in the intervention community was mainly due to the increased proportion of participants who reported consumption from pulse-based foods during the second 24h dietary diversity recall (result not shown), and this can be attributed to the intervention. The significant increase in pulse-consumption-indexes in this group also supports the positive effect of the intervention in increasing consumption frequency of pulse foods. However, the actual DDS of mothers-children only meets the minimum requirements for DDS at best, indicating a need to strengthen nutrition education efforts to move the median scores above the cut-points (i.e., a DDS of 4 to 5) for minimum requirements (FAO & Family Health International 360, 2016).

Findings based on the constructs of HBM (for mothers) also showed improvements in both communities, but greater improvements on perception scores were observed for the intervention community. In particular, 'perceived benefits of pulses' improved significantly only in the intervention community, and scores on 'perceived barriers to consumption of pulses' also dropped nearly twice as much in the intervention compared with the comparison community. Community-based intervention studies that applied the HBM constructs in rural communities of south Ethiopia have also reported improvement in knowledge, attitude and practice in areas of child feeding, as well as improvement in wasting and underweight, but not stunting, in the intervention communities (Mulualem et al., 2016; Tariku et al., 2015). Findings in the current study and similar communities indicate that effectiveness of nutrition education may be increased by the use of HBM to understand the perception of threat (posed by undernutrition) and benefits of and barriers to desired health behaviour or practice among rural Ethiopian women and applying this knowledge to shape the specific education.

Indeed, improvements in maternal anthropometric measures, such as mean BMI or the proportion with low BMI of $<18.5 kgm^{-2}$, did not differ significantly in either group in the pretest-posttest design. However, significant improvements in child anthropometric outcomes, such as mean BMI-for-age z scores and prevalence of child wasting, were reported for the intervention group; the latter has improved for the comparison community as well. A positive effect on short-term nutrition status markers of anthropometric indices has also been reported in similar communities elsewhere after six-months of educational intervention (Mulualem et al., 2016). Long-term nutritional status markers of anthropometric indices (such as height-for-age z-score, stunting and underweight prevalence) have not improved or became worse after six months in this study—though the magnitude of the drop in mean HAZ score in the intervention group was not as big as in the comparison group. The lack of or only limited improvements in the long-term nutritional status markers after six months of education intervention has also been reported by Mulualem et al. (2016) and another recipe based intervention (Negash et al., 2014) in a similar setting elsewhere in southern Ethiopia. This may indicate that the effect of educational nutrition interventions on chronic undernutrition indicators may not be fully captured or the interventions may not have been specific enough and/or the intervention period was too short to impact these indices.

Dietary intakes of energy and the selected nutrients among intervention mothers did not show significant improvement or the improvement did not differ from those in the comparison group; however, % RNI values of median intakes remained above the RNI, with the exception of energy and calcium. Dietary intakes of children, however, significantly improved in both the comparison and treatment groups. This was not unexpected as the children were, at least, six months older than what they were at baseline and expected to have increased dietary intake. However, improvement in the median values of the intake of energy and the selected nutrients did not differ between intervention and the comparison group at the end line measurement with the exception of iron, which was also significantly different between the groups at baseline. A study among young children in a similar setting by Negash et al. (2015) also reported a lack of significant changes in energy, iron and other macronutrient intakes following six months of nutrition education. Again, this may indicate lack of specificity of the intervention to impact the quantity of dietary intake, though the increased DDS meant improvement in the overall diet quality; or this may be due other factors (such as food supply and access to food), which this study failed to control for with the current design.

This study is among the first few intervention studies, if not the only, that attempted to comprehensively assess the effect of six months of educational nutrition intervention on the perceptions of benefits, knowledge, attitude and practice (including consumption frequency of certain foods), as well as dietary intake and nutritional status of mothers and children in pulse growing Ethiopian agricultural communities. The intervention was also carried out mostly by utilizing the existing infrastructure (the government run health and agriculture extension programs, mobilizing local people, keeping expert involvement to the minimum and increasing its feasibility for wider application in other settings with minimal budget implications. However, the study was too short and/or not specific enough (for example no feeding and/or recipe demonstration was involved) to detect significant positive impact on long-term markers of child undernutrition, such as mean HAZ score and stunting and underweight prevalence. Though the results may be generalizable to similar pulse-growing communities, the generalizability of the findings to non-pulse-growing communities may be limited, and education may need to be carefully adapted to new settings.

8.5. Conclusion

Overall, the findings indicated that a community-based nutrition education intervention, involving monthly interactive community conversation meetings and home visits, in traditionally pulse-growing communities could be effective in improving knowledge of benefits of pulses among rural mothers; pulse consumption frequency, and the subsequent improvement in dietary diversity among mothers and children, as well as improvement in the prevalence of short-term markers of undernutrition such as mean BMI-for-age Z scores and prevalence of wasting among children in rural Ethiopia. Results from focus group discussions with local farmers also indicated the positive effect of the intervention in raising the awareness of multiple benefits of pulses and increasing their intention to consume and produce more, as well as retain more for home consumption as opposed to selling the entire crop. The application of the principles of the HBM theory also appeared to strengthen the design, and implementation of the education making it relevant for the specific community.

Chapter 9 General discussion, strengths and limitations, and implications for future research

9.1. General discussion

The aims of this project were to compare and contrast nutrition situations in pulse or cereal communities, document evidence of pulse production translating to nutritional health benefits to mothers and children, and examine whether nutrition benefits of pulse production could be enhanced through nutrition education intervention among mothers and their young children in pulse-growing rural communities of Ethiopia. This project had identified the following three main objectives: (i) characterize health/nutrition situations and assess levels of maternal-child undernutrition along with gender, socioeconomic and demographic contextual factors; (ii) compare dietary practices and nutritional status of mothers and children in the pulse versus cereal-growing communities; and (iii) implement and assess the effect of a six-month nutrition education intervention, centred around pulse benefits, on the knowledge, attitude, practice (KAP) and nutritional status of mothers, as well as the nutritional status of children in the pulse community.

As described and discussed in earlier chapters, addressing maternal and child undernutrition has been a global concern and a priority nutrition agenda for Ethiopia. As such, a series of papers published in recent years with strong implications for nutrition policy have shown the magnitude of the problem and forwarded feasible solutions for the global community (Bhutta et al., 2008; Bhutta et al., 2013; Black et al., 2008; Black et al., 2013). Ethiopia was and, despite progress, continues to be one of the developing countries with a high burden of maternal and child undernutrition as reported in a series of DHS and other surveys (CSA & ICF International, 2012; EHNRI, 2010). Various advocacy tools have been used to improve the Ethiopian nutrition policy environment, including one that alerted the government to the high economic cost of not addressing undernutrition, particularly in children (African Union Commission et al., 2014; Hailu et al., 2013). The Government of Ethiopia also duly recognized the need for a more institutionalized and coordinated effort to address the country's nutrition concerns and introduced, in 2008, the first National Nutrition Strategy (NNS) (Ethiopia Federal MoH, 2008a) and National Nutrition Programme (NNP) (Ethiopia Federal MoH, 2008b). In each of these documents, addressing the nutrition of women and children was stated as top priorities.

The first three result chapters of this thesis **(Chapters 4-6** describing **Studies 1-3)** were baseline studies conducted five years into the implementation of the National Nutrition Programme of Ethiopia. Together, they provided comprehensive information regarding the mothers' and their children's nutritional status, food security environment and associated gender-household structure contextual factors in the rural communities selected for this research. Besides providing baseline information for the nutrition education intervention described in **Chapter 8 (i.e., Study 5)**, the studies also assessed overall rates of maternal and child undernutrition, infant and young child feeding practices and the food security situation. Such information should provide valuable feedback for local nutrition and health program implementers as to how well the services being provided through the NNP to mothers and children were taken to heart and/or whether levels of maternal and child undernutrition were dropping compared to previous national and regional reports, given now that it has been over five years since the first NNP was officially launched.

As shown in **Chapter 4**, the findings in both study districts indicated the existence of 'very high' levels of child stunting (up to 54%) and 'medium' (14%) to 'high' (22%) levels of maternal undernutrition, based on WHO classification for severity of stunting and maternal undernutrition (WHO, 2015; WHO Expert Committee on Physical Status, 1995). Although it was expected that some parts of the country would present a level of maternal or child undernutrition that may be higher than the national or regional averages, the levels reported here are unacceptably high and very concerning. It is even more concerning because this study took place in communities that had been supposedly benefiting from the implementation of the NNP, yet the level of child stunting, particularly in the two Halaba communities, was much higher and comparable to levels reported 15-20 years ago at regional or national levels (CSA and ORC Macro, 2001). It is also worth noting that these communities were selected on purpose for their pulse growing status—a characteristic that was hypothesized to have a positive influence on the nutrition and food security situation of these communities.

This first baseline study also documented limited utilization of health services by the majority of the mothers in both districts during their most recent pregnancy prior to the study. This limited utilization of health/nutrition services was evidenced in the lower rate of ANC visits (<4 times), very low rates of delivery at health facilities (~10%-18%) and by the poor dietary practices (85-95% not increasing their intake during pregnancy)—including food taboos—-the mothers reported during our survey. Poor appetite and/or feeling nauseated/sick, as well as the inability to access desired foods, were, in order of importance, the most frequent reasons mothers gave for not eating more during pregnancy. Many of these findings were similar to an earlier national survey conducted by EHNRI (2010) as a baseline for the national nutrition program. Perhaps health/nutrition program planners and implementers, while continuing to strengthen current services, should also pay increased attention to other contextual factors surrounding the nutrition/health environment of mothers and young children. In this study, significant association was reported between undernutrition, particularly of the children, and maternal consumption patterns during pregnancy, as well as gender and household structure variables such as empowerment imbalance between men and women, household size and physiological density. This may mean improving reproductive health for the women to maintain manageable family size, increasing nutrition awareness, enhancing productivity of farmland, empowering women, narrowing the education difference between men and women, so they may be in better position to look after themselves and their families.

Another key question investigated in **Study 2** (Ersino et al., 2016) was whether the feeding practices of infants and young children under 2y of age complied to WHO recommendations. The study explored both breastfeeding and complementary feeding practices within the critical window of the first 1000 days of life by using both subjective and objective methods. As shown in Chapter 5, IYCF practices were generally poor and indicated the existence of gaps in nutrition knowledge or poor adherence to WHO recommended feeding practices. Most of the feeding practices studied were found to be suboptimal compared to guidelines for international applications (WHO, 2008; WHO & UNICEF, 2003; WHO, UNICEF, & 1000 Days, 2014). Complementary foods for most of the children were of below 'minimum dietary diversity', 'minimum meal frequency' and, as a result, were below 'minimum acceptable diet' as defined by WHO (2010). Such poor feeding practices at this early and critical stage of development of children, would further exacerbate levels of stunting both in <2y and <5y of age children. Stunting has been associated with poor productivity, lower school performance, and poor health later in life, perpetuating undernutrition to the next generation. These findings, overall, call for the local government’s attention to revise or strengthen efforts to address maternal and child undernutrition should Ethiopia maintain its current progress and contribute to the global target of reducing stunting by 40% by 2025 (WHO, 2014) and end poverty and hunger by 2030 as stipulated in the new Sustainable Development Goals (United Nations, 2016).

The overwhelming majority of the households studied were food insecure and/or a significant proportion experienced some degree of household hunger, according to the assessment conducted using FANTA supplied tools for household food insecurity access (Coates et al., 2007) and hunger (Deitchler et al., 2011). **Study 3** assessed levels of household food insecurity (access) and household hunger in both Halaba and Zeway study communities, and also examined supply and demand side factors contributing to the food insecurity or hunger at household levels. The results were unacceptable—households classified as severely food insecure were as high as 67% in Zeway and 95% in Halaba communities. Household hunger (a severe form of food insecurity) also ranged from 18% in Zeway to 38% in Halaba communities. Though both *demand*- and *supply-side factors* contributed to the overall food insecurity and hunger in the pooled data, supply-side factors such as women's access to land, household cultivable land size, frequency of production per year and work-burden on women showed greater influence compared with demand-side factors. This also highlighted the challenging environment for improving the nutrition of women and young children. The high food insecurity may help explain the high prevalence of undernutrition measured in mothers and children from these communities.

Food insecurity continues to be an ongoing challenge for Ethiopia. A review of food security research in Ethiopia (Endalew et al., 2015) showed several factors such as the shortage of farmland, drought, erratic rainfall patterns, growing population pressure, poor productivity and land degradation as having links to food insecurity. Over 80% of Ethiopia's population resides in rural areas where agriculture is the mainstay. It has sustained itself for centuries relying on traditional wisdom and/or indigenous knowledge, passed on from past generations, to survive in its ecological environment. Building a sustainable and secure food system—utilizing all forms of physical and knowledge resources—is, therefore, imperative for the country to achieve self-sufficiency in food. Perhaps the integration of indigenous knowledges and technologies alongside 'modern ways' of food production remains largely an untapped resource the country has yet to utilize in the journey toward sustainable food security.

The value of indigenous knowledge in Africa and other 'non-Western societies' has been so undermined in this postcolonial era that prominent scholars such as C.A. Odora Hoppers and

H.A. Doughty call for a renewed attention for the inclusion of indigenous knowledge as a legitimate source of knowledge for sustainable future and human development (Doughty, 2005; Odora Hoppers, 2002, 2008). Others have highlighted the role of indigenous knowledge in agriculture, health and nutrition and called for the need to 'revitalize' indigenous knowledge through integration into the curricula of the formal education system (Muchenje & Goronga, 2013). Thus, it is fitting for Ethiopia to also consider, alongside efforts to improve agricultural productivity through modern technologies, properly documenting, preserving and utilizing indigenous knowledge resources in its quest to curb chronic food insecurity and toward a food secure and sustainable future.

Overall, the three baseline studies in this research helped to identify the community with the highest burden of undernutrition (from the three studied here), as well as the gaps in knowledge and practices for improved nutrition among women and their young children. These findings were utilized to develop and implement a nutrition intervention **(Study 5)** in one of the pulse growing communities with the highest burden of maternal and child undernutrition (discussed later).

Indeed, Ethiopia revisited and revised the initial NNP from 2008, and the revised NNP was officially launched in 2013 for the reminder of the two years prior to the end of MDGs in 2015 (FDRE, 2013). One of the studies that helped make a case for the revised NNP and raise the nutrition agenda higher up in the government structure was the "cost of hunger study in Africa", which included Ethiopia, in phase one of the study. Results from this study indicated that only in 2009 had Ethiopia lost a significant portion of its GDP (16.5%) to childhood undernutrition, followed by Rwanda and Malawi with 11.5% and 10.3% GDP losses for the same cause, respectively (African Union Commission et al., 2014). The revised NNP had specific targets of reducing child stunting from 44% to 30% and maternal undernutrition from 27% to 19% by the end of 2015. However, the 2014 mini DHS report indicated that stunting was down only to 40% (CSA, 2014), indicating the stunting target might not have been met by end of 2015.

As part of efforts to tackle undernutrition, nutrition specific programs such as direct supplementation or fortification may be necessary to correct nutrient deficiencies in the short-term. However, sustaining such programs for the long-term presents considerable challenges, particularly in poor countries, due to the logistics and infrastructure demands of such programs

(Gibson, 2006). Instead, food-based approaches such as diet diversification/modification have been recommended as more sustainable strategies (Gibson & Hotz, 2001). The food-based approach in part led to the emphasis on nutrition-sensitive agriculture, one that also focuses on bio-fortification and the growing of nutritious crops, including pulses.

Pulses have been known as good sources of plant protein, micronutrients and energy. They are also natural fertilizes, improving soil fertility and contributing to environmental sustainability. Pulses have been important food crops in Ethiopia, second to cereals. Despite their commonness and potential to improve nutrition situations in resource poor communities, the nutritional benefits of pulses have not been well pursued in Ethiopia, as shown in the lack of research on pulse nutrition in the period prior to the current research project.

The comparative study (**Chapter 7, Study 4**) assessed whether dietary intakes and consumption patterns, and overall nutrition of mothers and children in traditionally pulse growing communities would be better compared with those communities identified as mainly cereal growing. The study compared mothers-children's dietary intakes, dietary diversity, consumption frequency/index of selected foods, pulse agriculture/nutrition related knowledge and practices of mothers, as well as their nutritional status in the context of growing pulses or otherwise. Findings from this study indicated that median energy and nutrient (i.e., protein, iron, zinc, calcium) intakes in a subsample were significantly higher among the pulse than cereal mothers, but group intakes of these nutrients were lower for pulse children or did not differ. Median DDS was low at consumption from only three food groups, out of nine main FAO food groups, and there was no difference between pulse versus cereal community mothers or their children. This finding about low DDS was unexpected, particularly for the pulse communities since pulses are important cash crops, the proceeds of which could help purchase other food groups and increase their diet quality. However, pulse consumption index scores (proxy to frequency of pulse consumption), though higher in pulse mother-children, were generally low, denoting a consumption frequency of once or twice per week. Consumption from animal source foods, as well as fruits and vegetables, was very limited in both communities.

As described based on anthropometric findings in **Study 1,** higher rates of maternal undernutrition, child stunting, wasting and underweight were found in pulse than in cereal communities. This finding of higher undernutrition in pulse mothers and children was also unexpected and contrary to the study's hypothesis—that women and children from a pulse growing community have better nutritional status compared with those in a mainly cereal growing community. The basis for this hypothesis was the multiple benefits of growing pulses and their potential to contribute to improved nutrition and food security, hence nutritional status. In the MCA, selected factors, other than pulse production, which may have influenced the nutritional status of women and children were explored.

Women's access to land, the work-burden on women, child's age, mother's age and child stunting status were factors that predicted variations in maternal MUAC and child HAZ in the pulse community. Household size, sex of the child, number of ANC visits and child age also significantly explained variation in HAZ of cereal children. Additional results for the pulse community also indicated men controlled pulse harvest and mostly sold the produce at market. Women had limited control over pulse production; the proportion of pulse mothers with some knowledge of nutritional benefits of pulses was significantly lower compared with those in the cereal community. Overall, the pulse group, particularly children, did not have better dietary intakes or nutritional status despite being in the leading pulse producing communities.

Supporting findings on health behaviours of pulse versus cereal mothers (assessed using questions framed around the constructs of the Health Belief Model) indicated significant differences in perceptions/beliefs in three of the six domains. Pulse mothers had significantly lower average scores for perceived severity (based on questions around poor dietary practices); higher scores on perceived barriers to pulse consumption; and higher scores on cues to action (i.e., consumption of pulses) compared with their cereal counterparts. Pulse mothers also had lower scores on perceived benefits of pulses and self-efficacy (to take healthy steps in dietary practices) compared with cereal mothers, but differences were not significant. Overall, the findings indicated that the pulse-growing communities might benefit from a nutrition education intervention that would address the gaps in knowledge/perceptions in the area of pulses or other nutrition practices (additional details of these findings can be found in Appendix D).

Overall, this comparison study indicated that mere production of nutritious food crops may not necessarily translate to nutritional health benefits unless a bridging element is introduced in the system to connect production and consumption. This may include building enabling factors in the target community. Some of these enablers are that target communities need to be aware of and/or believe in their nutrition concerns and the cost of not taking action. Communities need to have some nutrition knowledge in order to want to—and be able to—

diversify/ modify their diet from locally available sources. Nutrition education interventions can play important roles in bridging such gaps in production and the actual nourishment of target populations. Recent pilot intervention studies in Ethiopia have shown promising results, where a community based nutrition education that promoted pulse foods improved mothers' nutrition awareness and also IYCF practices, leading to improvement in the diet and nutritional status of children (Mulualem et al., 2016; Negash et al., 2014)

Taking into account the baseline findings of the high burden of undernutrition and gaps in nutrition knowledge, including an understanding of nutrition and other benefits of pulses, a quasi-experimental intervention study **(Study 5)** was implemented in the two pulse-growing communities of Halaba, where the community with a higher burden of undernutrition was assigned to receive a six-month nutrition education intervention emphasizing nutrition and other benefits of pulses through interactive monthly community meetings and home visits. The other pulse community served as a comparison community. The findings of the intervention study indicated positive benefits of the intervention in terms of significantly improving the knowledge of pulses and their nutritional advantages, attitudes and practices of mothers, as well as the nutritional status of children. Intervention mothers had significantly improved knowledge of pulse benefits; and improved their and their children's pulse consumption frequency. As a result, there was improvement in mother-child median DDS, as well as significant improvement in short-term markers of undernutrition (such as BMI-for-age Z-scores and rate of wasting) among the intervention children, which was not seen in comparison community. Qualitative findings from FGD of local farmers indicated increased awareness of the multiple benefits of pulses, as well as their intentions to produce and consume more pulses, instead of selling all their produce for cash income, which may or may not come back to improve the nutrition of women and children.

In summary, the intervention study **(Study 5)** has shown that a community-based nutrition education involving active participation of community members could provide feasible and sustainable approaches to tackling problems related to malnutrition in Ethiopia. In this study, nutrition education intervention involving monthly interactive community meetings and home-visits, improved KAP and perceptions of mothers regarding pulse nutrition benefits and the subsequent DDS and frequency of consumption of targeted food groups; there was also improvement in children’s short-term nutritional status indicators. Male farmers were able to understand the multiple benefits of pulse agriculture and showed positive intentions to produce and consume a more pulse based diet, also allow their women to use more of the pulses for home consumption, instead of selling most or all of their pulses to the market. Several of the findings from the baseline studies that showed the existence of a high burden of maternal and child undernutrition and suboptimal child feeding practices, which are believed generalizable to other similar rural communities, call for strengthening and revising existing nutrition and other services by the local and national government to help improve the overall nutrition environment for the most vulnerable segment of the population—mothers and children.

9.2. Strengths and limitations

Some of the strengths of this research project which the researcher believe could benefit local nutrition program planners and implementers, include the following: (i) it provided comprehensive information on the nutrition of mothers and children, including assessment of levels of maternal-child undernutrition, with associated socioeconomic-demographic contextual factors, dietary intake, consumption patterns of selected food groups, dietary diversity, household food security situations, health beliefs/behaviors of mothers and infant and young child feeding practices; (ii) it documented evidence on whether pulse agriculture translates to nutrition health benefits among mothers and children (i.e., exploring the agriculture-nutrition link) in a comparative study of traditionally pulse or mainly cereal growing rural communities in Ethiopia, informing interventions in pulse agriculture and the nutrition of populations; (iii) it utilized findings from the baseline studies to develop and implement a six-month educational nutrition intervention through a quasi-experimental intervention design and mainly involving the local people as educators or active participants, thereby showing promising results and lessons for future intervention programs on a lager scale.

Specific limitations pertinent to the design or methods of individual studies have been provided along with the respective chapters. However, the following could add to the overall limitations of the current research: the duration of the intervention was short particularly considering that it involved seasonal agricultural practices (i.e., production of pulse crops) the frequency of which did not necessarily happen within the six months of intervention – the intervention began shortly after pulse harvest was completed and ended shortly before the next pulse production season. As a result, the post intervention study assessed only 'intentions' of the farmers to produce and/ or retain more pulses for home consumption. The short duration of the study might have also limited the intervention's positive effect on some of the outcome measures (such as energy and nutrient intake, prevalence of child stunting and maternal undernutrition); the cereal growing community was not purely cereal growing as close to half of households studied reported growing some pulses; nevertheless, this community provided a useful reference point while comparing nutrition situations with the pulse growing communities where nearly all households reported producing some type of pulse crop.

9.3. Implications and future direction

As alluded to in previous sections, the baseline studies provided useful information that may provide valuable feedback to the local nutrition program planners/implementers regarding the burden of maternal and child undernutrition, with socioeconomic-demographic contextual factors, five years into the implementation of the Ethiopian National Nutrition Program. It also provided information on household food security situations and dietary habits of mothers and children, including infant and young child feeding practices, by using multiple dietary assessment tools. The comparative study also showed that production of nutritious crops such as pulses did not necessarily translate to nutritional health benefits as the study found that overall diet and nutritional status of mothers and children were not better for the pulse producing communities. However, the nutrition education intervention conducted in the pulse-growing communities had a modest but significantly positive effect on the nutrition of mothers and children, particularly in the intervention community.

Even though the country has made significant strides in making nutrition one of its priority agenda items, the findings in this research project raise concerns with implications for the current nutrition program/policy of Ethiopia. The baseline pulse versus cereal comparison, as well as the nutrition education intervention studies, indicate:

- The need to revise and/ or strengthen by the local government implementers, the existing nutrition services, as well as their delivery strategies being offered through the national Health Extension programs, in order to improve IYCF/dietary practices and help accelerate reduction of undernutrition in both mothers and children;
- The need to integrate nutrition education with agricultural practices, thereby facilitating pathways to nutrition benefits;

- The need to recognize the importance of improving the household food security environment by considering strategies such as increasing productivity, improving women's access to own farmland, and reducing women's work burdens;
- The need to strengthen nutrition education, involving active participation from local communities, to optimize nutrition benefits of locally available foods and thereby help reduce the high burden of undernutrition in vulnerable populations.

Given that the current thesis research was one of the first to examine whether pulse agriculture translates to nutrition benefits, future studies should expand on the current findings, while addressing the limitations reported here, including, but not limited to, the short duration of the intervention study.

Over the last decade, Ethiopia has enjoyed an increased attention from its central government in the area of improving the nutrition situation of the country, particularly of women and children. Although nutrition activities were there in the pre 2008 period, they were mostly not coordinated and emergency-nutrition oriented. However, due to the significant burden of malnutrition and the Ethiopian Government's development plan that included the health sector, the National Nutrition Strategy and the National Nutritional Programmes were introduced in 2008 for the first time. The nutrition programs aimed to improve and strengthen nutrition services both at the health facility and the community levels. These programs utilized the national Health Extension Program (HEP) as a service delivery platform. The HEP itself is intended to provide basic curative and preventive health services, including nutrition, at a community level all over the country. Ethiopia also established various initiatives to accelerate reduction in child stunting and relaunched a revised version of the NNP in 2013 with the hope meeting some of the nutrition-related Millennium Development Goals by the end of 2015. However, despite the commendable pro-nutrition environment and political commitment at a national level (including setting nutrition related goals in the country's five-year Growth and Transformation Plan), there still remains a high burden of maternal and child undernutrition as reported here and also based on the 2014 mini-DHS survey where stunting was reported to be high at 40%.

Going forward, the country needs to reconsider and monitor the nutrition programs and ensure the implementation of these programs at the grass-roots level. Ethiopia relies on the

Health Extension Program as its nutrition service delivery platform at the community level. Hence, it is imperative that Ethiopia should build the capacity of health and agriculture extension workers, through in-service or pre-service training, in the delivery of nutrition specific and nutrition sensitive activities at the community levels. Building such capacity at grass-root levels may require making use of nutrition professionals currently trained in the various local universities. Since Ethiopia is also an agricultural society for the most part, investing in pro-nutrition agriculture, addressing the gender gaps through empowering women (e.g., ensuring access to formal schooling, farmland, employment, and water) will contribute to the fight against chronic undernutrition in both mothers and young children.

Investing in nutrition literacy of the general population through training of qualified nutrition professionals and allowing them to handle nutrition tasks, instead of assigning nutrition specific jobs as a side duty to already busy health professionals, is another key area the country needs to look at going forward. This way, Ethiopia will be better positioned to actualize its own declaration—the *Seqota Declaration* of ending hunger and undernutrition by 2030 (COMPACT2015, 2015; SUN Country Network, 2015)— an initiative in line with the new Sustainable Goals.

References

1000 Days. (2015). *Reaching the global target to reduce stunting: How much will it cost and how can we pay for it?* Retrieved from http://thousanddays.org/tdays-content/uploads/Stunting-Costing-and-Financing-Overview-Brief.pdf

Abebe, Y., Bogale, A., Hambidge, K. M., Stoecker, B. J., Arbide, I., Teshome, A., . . . Gibson, R. S. (2008). Inadequate intakes of dietary zinc among pregnant women from subsistence households in Sidama, Southern Ethiopia. *Public Health Nutrition, 11*(4), 379-386. doi:10.1017/S1368980007000389

Abuya, B. A., Ciera, J. M., & Kimani-Murage, E. (2012). Effect of mother's education on child's nutritional status in the slums of Nairobi. *BMC Pediatrics, 12*(1), 80. doi:10.1186/1471-2431-12-80

Abuye, C., & Berhane, Y. (2007). The goitre rate, its association with reproductive failure, and the knowledge of iodine deficiency disorders (IDD) among women in Ethiopia: cross-section community based study. *BMC Public Health, 7*, 316. doi:10.1186/1471-2458-7-316

Achterberg, C., & Miller, C. (2004). Is one theory better than another in nutrition education? A viewpoint: More is better. *Journal of Nutrition Education and Behavior, 36*(1), 40-42. doi:http://dx.doi.org/10.1016/S1499-4046(06)60127-9

African Union Commission, NEPAD Planning and Coordinating Agency, UN Economic Commission for Africa, & UN World Food Programme. (2014). *The cost of hunger in Africa: Social and economic impact of child undernutrition in Egypt, Ethiopia, Swaziland and Uganda*. Addis Ababa, Ethiopia: UN Economic Commission for Africa.

Ajzen, I. (1985). From intention to Actions: A theory of planned behaviour. In J. Kahul & J. Beckmann (Eds.), Action control: From cognition to behaviour (pp. 11-39). Heidelberg, Germany: Springer.

Alderman, H., & Berman, J. R. (2004). *Estimated economic benefits of reducing low birth weight in low-income countries* (Vol. 1). Washington, DC: The International Bank for Reconstruction and Development / The World Bank.

Alem, H. (2013). *Rural households' transitory food insecurity and coping strategies in Ethiopia highland*. Paper presented at the Sixth International Conference on Agricultural Statistics

(ICAS VI), Rio De Janeiro, Brazil. http://eventos.ibge.gov.br/en/icas2013/programa-da-conferencia/sessao-de-poster#

Ali, D., Saha, K. K., Nguyen, P. H., Diressie, M. T., Ruel, M. T., Menon, P., & Rawat, R. (2013). Household food insecurity is associated with higher child undernutrition in Bangladesh, Ethiopia, and Vietnam, but the effect is not mediated by child dietary diversity. *The Journal of Nutrition, 143*(12), 2015-2021. doi:10.3945/jn.113.175182

Ali, H., Khan, M. A., & Randhawa, S. A. (2004). Interactive effect of seed inoculation and phosphorus application on growth and yield of chickpea (Cicer arietinum L.). *International Journal of Agricultural Biology, 6*(1), 110-112.

Alive & Thrive. (2014). *Overview of the approach for mobilizing families and communities in Ethiopia to adopt seven feeding actions*. Addis Ababa, Ethiopia: Alive & Thrive.

Alive and Thrive. (2010). *Insight: Why stunting matters*. Retrieved from https://www.fhi360.org/sites/default/files/media/documents/Insight%20-%20Why%20stunting%20matters%20(English).pdf

Allendorf, K. (2007). Do Women's Land Rights Promote Empowerment and Child Health in Nepal? *World Development, 35*(11), 1975-1988. doi:10.1016/j.worlddev.2006.12.005

Anderson, L. C., Tegegn, A., Tessema, F., Galea, S., & Hadley, C. (2012). Food insecurity, childhood illness and maternal emotional distress in Ethiopia. *Public Health Nutrition, 15*(4), 648-655. doi:10.1017/S1368980011001340

Arimond, M., & Ruel, M.T. (2004). Dietary diversity is associated with child nutritional status: Evidence from 11 Demographic and Health Surveys. *Journal of Nutrition, 134*, 2579-2585.

Ashmad, Alfiyah , Giroud, Severine , Bait, Blandina , & Ragalawa, Hai (2012). *Gender rapid assessment report: Gender issues in food and nutrition security in Nusa Teggeara Timur Province*. Retrieved from https://www.wfp.org/sites/default/files/WFP-Gender%20Rapid%20Assesment.pdf

Aubel, J., & Samba-Ndure, K. (1996). Lessons on sustainability for community health projects. *World Health Forum, 17*(1), 52-57.

Aubel, Judi, Touré, Ibrahima, Diagne, Mamadou, Lazin, Kalala, Sène, El Hadj Alioune, Faye, Yirime, & Tandia, Mouhamadou. (2001). Strengthening grandmother networks to improve community nutrition: Experience from Senegal. *Gender and Development, 9*(2), 62-73. doi:10.1080/13552070127743

Bandura, Albert. (1999). Social cognitive theory: An agentic perspective. *Asian Journal of Social Psychology, 2*, 21-41.

Banteyerga, Hailom. (2011). Ethiopia's Health Extension Program: Improving Health through Community Involvement. *MEDICC Review, 13*(3), 46-49.

Bekabil, Urgessa Tilahun. (2014). Review of Challenges and Prospects of Agricultural Production and Productivity in Ethiopia. *Journal of Natural Sciences Research, 4*(18).

Belachew, T., Lindstrom, D., Gebremariam, A., Hogan, D., Lachat, C., Huybregts, L., & Kolsteren, P. (2013). Food insecurity, food based coping strategies and suboptimal dietary practices of adolescents in Jimma zone Southwest Ethiopia. *PloS One, 8*(3), e57643. doi:10.1371/journal.pone.0057643

Belachew, T., Lindstrom, D., Gebremariam, A., Jira, C., Hattori, M. K., Lachat, C., . . . Kolsteren, P. (2012). Predictors of chronic food insecurity among adolescents in Southwest Ethiopia: a longitudinal study. *BMC Public Health, 12*, 604. doi:10.1186/1471-2458-12-604

Belachew, T., Lindstrom, D., Hadley, C., Gebremariam, A., Kasahun, W., & Kolsteren, P. (2013). Food insecurity and linear growth of adolescents in Jimma Zone, Southwest Ethiopia. *Nutrition Journal, 12*, 55. doi:10.1186/1475-2891-12-55

Beyene, M., Worku, A. G., & Wassie, M. M. (2015). Dietary diversity, meal frequency and associated factors among infant and young children in Northwest Ethiopia: a cross-sectional study. *BMC Public Health, 15*(1007), 1007. doi:10.1186/s12889-015-2333-x

Bezner Kerr, R., Berti, P. R., & Shumba, L. (2011). Effects of a participatory agriculture and nutrition education project on child growth in northern Malawi. *Public Health Nutrition, 14*(8), 1466-1472. doi:10.1017/S1368980010002545

Bezner Kerr, R., Dakishoni, L., Shumba, L., Msachi, R., & Chirwa, M. (2008). "We grandmothers know plenty": Breastfeeding, complementary feeding and the multifaceted role of grandmothers in Malawi. *Social Science and Medicine, 66*(5), 1095-1105. doi:10.1016/j.socscimed.2007.11.019

Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K., Giugliani, E., & Maternal Child Undernutrition Study Group. (2008). What works? Interventions for maternal and child undernutrition and survival. *Lancet, 371*(9610), 417-440. doi:10.1016/S0140-6736(07)61693-6

Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., & Maternal Child Nutrition Study Group. (2013). Evidence-based interventions for improvement of maternal and child nutrition: what can be done and at what cost? *Lancet, 382*(9890), 452-477. doi:10.1016/S0140-6736(13)60996-4;

Binkin, N. J., Yip, R., Fleshood, L., & Trowbridge, F. L. (1988). Birth weight and childhood growth. *Pediatrics, 82*(6), 828-834.

Birhane, T., Shiferaw, S., Hagos, S., & Mohindra, K. S. (2014). Urban food insecurity in the context of high food prices: a community based cross sectional study in Addis Ababa, Ethiopia. *BMC Public Health, 14*, 680. doi:10.1186/1471-2458-14-680

Black, Maureen M. (2005, September 19). *The Impact of Nutrition on Cognition from Infancy through School-Age.* Paper presented at the Nutrition and Cognition in Children: Unilever Pre-Congress Workshop, 18th International Nutrition Congress, Durban, South Africa.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., . . . Child Undernutrition Study, Group. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet, 371*(9608), 243-260. doi:10.1016/S0140-6736(07)61690-0

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z. A., Christian, P., de Onis, M., . . . Child Nutrition Study Group. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet, 382*(9890), 427-451. doi:10.1016/S0140-6736(13)60937-X

Bouchenak, M., & Lamri-Senhadji, M. (2013). Nutritional quality of legumes, and their role in cardiometabolic risk prevention: a review. *Journal of Medicinal Food, 16*(3), 185-198. doi:10.1089/jmf.2011.0238

Brown, K. H., Peerson, J. M., Rivera, J., & Allen, L. H. (2002). Effect of supplemental zinc on the growth and serum zinc concentrations of prepubertal children: A meta-analysis of randomized controlled trials. *American Journal of Clinical Nutrition, 75*(6), 1062-1071.

Buchanan, David. (2004). Two models for defining the relationship between theory and practice in nutrition education: Is the scientific method meeting our needs? *Journal of Nutrition Education and Behavior, 36*(3), 146-154. doi:10.1016/s1499-4046(06)60152-8

Bureau of Women Youth and Children Affairs. (2013). *Situational analysis of boys and girls in SNNPR: A rights-based approach*. Bureau of Women Youth and Children Affairs. Hawassa, Ethiopia.

Carlson, G. J., Kordas, K., & Murray-Kolb, L. E. (2015). Associations between women's autonomy and child nutritional status: a review of the literature. *Maternal & Child Nutrition*, *11*(4), 452-482. doi:10.1111/mcn.12113

Central Intelligence Agency. (2015). The World Factbook. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/et.html

Chadha, V.K. . (2006). Sample size determination in health studies. *National Tuberclosis Institute Bulletin, 42*(3 & 4), 55-62.

Champ, M. M. (2002). Non-nutrient bioactive substances of pulses. *Brition Journal of Nutrition, 88 Suppl 3*, S307-319. doi:10.1079/BJN2002721

Champion, V. L., & Skinner, C. S. (2008). The Health Belief Model. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health Behaviour and Health Education: Theory, Research and Practice* (Vol. 4th Edition, pp. 45-62). USA: John Wiley & Sons. Inc.

Charan, J., & Biswas, T. (2013). How to calculate sample size for different study designs in medical research? *Indian Journal of Psychological Medicine, 35*(2), 121-126. doi:10.4103/0253-7176.116232

Coates, J., Swindale, A., & Bilinsky, P. (2007). *Household Food Insecurity Access Scale (HFIAS) for Measurement of Household Food Access: Indicator Guide (v. 3)*. Retrieved from http://www.fantaproject.org/downloads/pdfs/HFIAS_v3_Aug07.pdf

Cochrane, Logan. (2011). Food security or food sovereignty: The case of land grabs *The Journal of Humanitarian Assistance*. http://sites.tufts.edu/jha/archives/1241

Commission on Social Determinants of Health. (2008). *Closing the gap in a generation: Health equity through action on the social determinants of health. Final report of the Commission on Social Determinants of Health*. Geneva, Switzerland World Health Organization.

COMPACT2015. (2015). *Ethiopia Ending Hunger & Undernutrition: Challenges & Opportunities*. Retrieved from http://www.compact2025.org/files/2016/03/Ethiopia-Draft-Scoping-Report_v3cover.pdf

Contento, I. R. (2008). Review of nutrition education research in the Journal of Nutrition Education and Behavior, 1998 to 2007. *Journal of Nutrition Education and Behavior, 40*(6), 331-340. doi:10.1016/j.jneb.2008.06.001

Contento, I. R. (2011). *Nutrition education: Linking research, theory and practice* (Second ed.). Sudbury, MA: Jones and Bartlett Publishers, LLC.

Contento, I. R., Balch, G. I., Bronner, Y. L., Lytle, L. A., Maloney, S. K., Olson, C. M., & Swadener, S. S. (1995). The effectiveness of nutrition education and implications for nutrition education policy, programs and research: a review of research (Abstract). *Journal of Nutrition Education, 27*(6), 277-418.

Crewett, W., Bogale, A., & Korf, B. . (2008). *Land Tenure in Ethiopia: Continuity and Change, Shifting Rulers, and the Quest for State Control. CAPRi Working Paper 91*. Retrieved from http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/24652

CSA. (2007). *Part I - population size and characteristics, Central Statistical Agency, 2010-07, Ethiopia*. Retrieved from http://www.csa.gov.et/index.php/2013-02-20-14-51-51/2013-04-01-11-53-00/census-2007.

CSA. (2009). *Agricultural sample survey 2008/2009 (2001 E.C.), (September – December 2008) Volume I, report on: Area and production of crops (private peasant holdings, meher season)*. Addis Ababa, Ethiopia: Central Statistical Agency (CSA).

CSA. (2014). *Ethiopia Mini Demographic and Health Survey 2014*. Addis Ababa, Ethiopia: Central Statistical Agency.

CSA. (2015a). *Agricultural Sample Survey (From 1995/96 (1988 E.C) - 2014/15 (2007 E.C): Time Series Data for National & Regional Level: Report on Area and Productivety of Crops (Private Peasant Holdings, Meher season)*. Addis Ababa, Ethipia: Central Statistics Agency of Ethiopia Retrieved from http://www.csa.gov.et/images/general/news/agss_time_series%20report.

CSA. (2015b). *Key findings of the 2014/2015 (2007 E.C.) agricultural sample surveys: Country summary*. Addis Aababa, Ethiopia: Central Statistics Agency.

CSA. (2016). *Agricultural Sample Survey 2015/2016 (2008 E.C.) Volume I: Report on area and production of major crops (Private peasant holdings, Meher Season)*. Addis Ababa, Ethiopia: Central Statistical Agency (CSA) of Ethiopia.

CSA & ICF International. (2012). *Ethiopia Demographic and Health Survey 2011*. Addis Ababa, Ethiopia & Calverton, MD: Central Statistical Agency & ICF International.

CSA and ORC Macro. (2001). *Ethiopia Demographic and Health Survey 2000*. Addis Ababa, Ethiopia & Calverton, MD: Central Statistical Agency and ICF International.

CSA and ORC Marco. (2006). *Ethiopian Demographic and Health Survey 2005*. Addis Ababa, Ethiopia & Calverton, MD: Central Statistical Agency and ICF International.

Deitchler, M., Ballard, T. , Swindale, A., & Coates, J. (2010). *Validation of a Measure of Household Hunger for Cross-Cultural Use*. Retrieved from http://www.fantaproject.org/sites/default/files/resources/HHS_Validation_Report_May2010_0.pdf

Deitchler, M., Ballard, T., Swindale, A., & Coates, J. (2011). *Introducing a Simple Measure of Household Hunger for Cross-Cultural Use*. Retrieved from http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/HH_Hunger_Scale.pdf

Devereux, S. (2000). *Food insecurity in Ethiopia: A discussion paper for DFID*. Retrieved from https://www.ids.ac.uk/files/FoodSecEthiopia4.pdf

Devereux, S., Sabates-Wheeler, R., Tefera, M., & Taye, H. (2006). *Ethiopia's Productive Safety Net Programme (PSNP): Trends in PSNP Transfers Within Targeted Households, Final Report*. Retrieved from http://www.ids.ac.uk/files/PSNPEthiopia.pdf

Dewey, K.G., & Brown, K.H. (2003). Update on technical issues concerning complementary feeding of young children in developing countries and implications for intervention programs. *Food Nutrition Bulletin, 24*(1), 5-28.

Doughty, Howard A. . (2005). Indigenous Knowledge in a Postcolonial Context. [Review of the book Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation, by C. A. Odora Hoppers, editor]. *The Innovation Journal: The Public Sector Innovation Journal, 10*(3), 10.

Ecker, O., Mabiso, A., Kennedy, A., & Diao, X. (2011). *Making Agriculture Pro-Nutrition: Opportunities in Tanzania*. Retrieved from http://dspace.cigilibrary.org/jspui/bitstream/123456789/32312/1/IFPRI%20-%20Making%20Agriculture%20Pro-Nutrition.pdf?1

EHNRI. (1998a). *Food composition table for use in Ethiopia (1968-1997): Part III*. Addis Ababa, Ethiopia: Ethiopian Health and Nutrition Research Institute (EHNRI).

EHNRI. (1998b). *Food compostion table for use in Ethiopia (1995-1997): Part IV*. Addis Ababa, Ethiopia: Ethiopian Health and Nutrition Research Institute (EHNRI)

EHNRI. (2010). *Nutrition baseline survey report for the National Nutrition Program of Ethiopia*. Retrieved from http://www.ephi.gov.et/images/nutrition/nutrition%20baseline%20survey%20report.pdf

Elder, John P., Ayala, Guadalupe X., & Harris, Stewart. (1999). Theories and intervention approaches to health-behavior change in primary care. *American Journal of Preventive Medicine, 17*(4), 275-284. doi:http://dx.doi.org.cyber.usask.ca/10.1016/S0749-3797(99)00094-X

Endale, W., Mengesha, Z. B., Atinafu, A., & Adane, A. A. (2014). Food insecurity in Farta District, Northwest Ethiopia: a community based cross-sectional study. *BMC Research Notes, 7*, 130. doi:10.1186/1756-0500-7-130

Endalew, B. , Muche, M. , & Tadesse, S. . (2015). Assessment of food security situation in Ethiopia: A Review. *Asian Journal of Agricultural Research, 9*, 55-68. doi:10.3923/ajar.2015.55.68

Ersino, G., Henry, C. J., & Zello, G. A. (2016). Suboptimal feeding practices and high levels of undernutrition among infants and young children in the rural communities of Halaba and Zeway, Ethiopia. *Food Nutrition Bulletin, 37*(3), 409-424. doi:10.1177/0379572116658371

Ersino, G., Tadele, H., Bogale, A., Abuye, C., & Stoecker, B. J. (2013). Clinical assessment of goiter and low urinary iodine concentration depict presence of severe iodine deficiency in pregnant Ethiopian women: a cross-sectional study in rural Sidama, southern Ethiopia. *Ethiopian Medical Journal, 51*(2), 133-141.

Ersino, Getahun. (2011). *The need for professional training/education in nutrition education and communication in Ethiopia: Report commissioned by the Food and Agriculture Organization of the United Nations, Nutrition Education and Consumer Awareness Group, Nutrition and Consumer Protection Division (AGN)*. Retrieved from http://www.fao.org/ag/humannutrition/nutritioneducation/69725/en/

Ersino, Getahun, Zello, Gordon A., & Henry, Carol J. (2015). *Application of the Health Belief Model to understand the behavior of mothers in pulse or cereal-growing rural* *communities in Ethiopia*. Poster abstract presented at the 22nd Annual Life and Health Science Research Day, University of Saskatchewan, Saskatoon, Canada

Ethiopia Federal MoH. (2008a). *National Nutriton Strategy*. Addis Ababa, Ethiopia: Ministry of Health (MoH), Federal Democratic Republic of Ethiopia Retrieved from http://iycn.wpengine.netdna-cdn.com/files/National-Nutrition-Strategy.pdf.

Ethiopia Federal MoH. (2008b). *Program Implementation Manual of National Nutrition Program (NNP)–I July 2008 –June 2010*. Addis Ababa, Ethiopia: Federal Ministry of Health (MoH).

Ethiopian Export Promotion Agency. (2004). *Ethiopia, Land of Crop Diversity: Ethiopian Pulses Profile*. Retrieved from http://www.eap.gov.et/sites/default/files/Ethiopian%20Pulses%20Profile.pdf.

Fahmida, Umi, Rumawas, Johanna S. P., Utomo, Budi, Patmonodewo, Soemiarti, & Schultink, Werner. (2007). Zinc-iron, but not zinc-alone supplementation, increased linear growth of stunted infants with low haemoglobin. *Asia Pacific Journal of Clinical Nutrition, 16*(2), 301-309.

Famine Early Warning Systems Network. (2009). *Ethiopia food security update*. Retrieved from http://www.fews.net/docs/Publications/ethiopia_fsu_2009_08_final.pdf

FAO. (1996). *Rome declaration on world food security and world food summit plan of action: World Food Submit 13-17 November 1996* Retrieved from http://www.fao.org/docrep/003/w3613e/w3613e00.HTM

FAO. (2004). *Human energy requirements: Report of a Joint FAO/WHO/UNU Expert Consultation Rome, 17–24 October 2001*. Retrieved from http://www.fao.org/3/a-y5686e.pdf

FAO. (2008). *Nutrition country profiles: Federal Democratic Republic of Ethiopia*. Retrieved from http://www.fao.org/ag/agn/nutrition/eth_en.stm

FAO. (2010). *Gender and Nutrition (Fact sheet)* Retrieved from http://www.fao.org/docrep/012/al184e/al184e00.pdf

FAO. (2011). *The state of food and agriculture 2010-2011: Women in agriculture - closing the gender gap for development*. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO. (2012). *Gender and nutrition: Draft*. Retrieved from http://www.fao.org/fileadmin/user_upload/wa_workshop/docs/Gender-Nutrition_FAO_IssuePaper_Draft.pdf

FAO. (2015). *Global information and early warning system on food and agriculture: Ethiopia country brief*. Retrieved from http://www.fao.org/giews/countrybrief/country/ETH/pdf/ETH.pdf

FAO & Family Health International 360. (2016). *Minimum dietary diversity for women: A guide for measurement*. Rome, Italy: Food and Agriculture Organization of the United Nations.

FAO & WFP. (2009). *Special report- FAO/WFP crop and food security assessment mission to Ethiopia (Phase 2): Integrating the crop and food supply and the emergency food security assessments*. Retrieved from http://www.fao.org/docrep/012/ak336e/ak336e00.htm

FAO & WFP. (2010). *Special Report: FAO/WFP Crop and Food Security Assessment Mission to Ethiopia*. Retrieved from http://www.fao.org/docrep/012/ak346e/ak346e00.pdf

FAO & WFP. (2012). *Special Report: FAO/WFP crop and food security assessment mission to Ethiopia*. Retrieved from http://www.fao.org/docrep/015/al987e/al987e00.pdf

FAO, WFP & IFAD. (2012). *The state of food insecurity in the world 2012: Economic growth is necessary but not sufficient to accelerate reduction of hunger and malnutrition*. Rome, Italy: Food and Agricutlure Organization of the United Nations.

FAO & WHO. (2004). *Vitamin and mineral requirements in human nutrition* (Second ed.). Geneva. Switzerland and Rome, Italy World Health Organization and Food and Agriculture Organization of the United Nations.

FAO, & WHO. (2007). *Codex Alimentarius: Cereals, pulses, legumes and vegetable proteins* (First ed.). Rome, Italy: FAO and WHO.

FDRE. (2013). *National Nutrition Programme June 2013-June 2015*. Addis Ababa, Ethiopia: Federal Democratic Republic of Ethiopia (FDRE), Retrieved from http://www.usaid.gov/sites/default/files/documents/1867/National%20Nutrition%20Programme.pdf.

Federal Ministry of Health of Ethiopia. (2005). *Health Sector Strategic Plan (HSDP-III) 2005/6-2009/10*. Addis Ababa, Ethiopia: FMoH Planning and Programming Department

Retrieved from http://can-mnch.ca/wp-content/uploads/2013/09/Ethiopia-Health-Sector-Development-PlanHSDP-III.pdf.

Feleke, S.T., Kilmer, R.L., & Gladwin, C.H. . (2005). Determinants of food security in Southern Ethiopia at the household level. *Agricultural Economics*, *33*, 351-363.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behaviour: An introduction to theory and research*. Menlo Park, CA: Addison-Wesley Publishing Company, Inc.

Fisher, A.A., Laing, J.E., Stoeckel, J.E., & Townsend, J.W. (1998). *Handbook for family planning operations research design* (Second ed.). New York, NY: Population Council.

Frisancho, A. R. (1990). *Anthropometric standards for the assessment of growth and nutritional status*. Ann Arbor, MI: The University of Michigan Press.

Gebremedhin, S., Enquselassie, F., & Umeta, M. (2011). Prevalence of prenatal zinc deficiency and its association with socio-demographic, dietary andhealth care related factors in Rural Sidama, Southern Ethiopia: A cross-sectional study. *BMC Public Health, 11*, 898. doi:10.1186/1471-2458-11-898

Gebreselassie, S. G., & Gashe, F. E. (2011). A systematic review of effect of prenatal zinc supplementation on birthweight: Meta-analysis of 17 randomized controlled trials. *Journal of Health, Population & Nutrition, 29*(2), 134-140.

Getenesh, Birhanu, Addisalem, Mesfin, Afework, Kebebu, Whiting, S. J., & Henry, C. J. (2014). Household food processing methods to enhance iron and zinc bioavailability in formulated haricot bean and maize complementary food. *African Journal of Food Science, 8*(4), 190-195. doi:1041.5897/AJFS2014.11

Gibson, R. S. (2005a). Measuring food consumption of individuals *Principles of nutritional assessment* (Vol. Second, pp. 41-60). New York, NY: Oxford University Press, Inc.

Gibson, R. S. (2005b). *Principles of nutritional assessment* (Second ed.). New York, NY: Oxford University Press, Inc.

Gibson, R. S. (2006). Zinc: The missing link in combating micronutrient malnutrition in developing countries. *Proceedings of the Nutrition Society, 65*(1), 51-60. doi:10.1079/pns2005474

Gibson, R. S., Abebe, Y., Hambidge, K. M., Arbide, I., Teshome, A., & Stoecker, B. J. (2009). Inadequate feeding practices and impaired growth among children from subsistence farming households in Sidama, Southern Ethiopia. *Maternal and Child Nutrition, 5*(3), 260-275. doi:10.1111/j.1740-8709.2008.00179.x

Gibson, R. S., Abebe, Y., Stabler, S., Allen, R. H., Westcott, J. E., Stoecker, B. J., . . . Hambidge, K. M. (2008). Zinc, gravida, infection, and iron, but not vitamin B-12 or folate status, predict hemoglobin during pregnancy in southern Ethiopia. *Journal of Nutrition, 138*(3), 581-586.

Gibson, R. S., & Hotz, C. (2001). Dietary diversification/modification strategies to enhance micronutrient content and bioavailability of diets in developing countries. *British Journal of Nutrition, 85 Suppl 2*, S159-166.

Glanz, K., Rimer, B. K., & Viswanath, K. (2008). *Health behavior and health education: Theory,research and practice* Vol. 4th. Retrieved from http://www.sanjeshp.ir/phd/phd_91/Pages/Refrences/health%20education%20and%20promotion/[Karen_Glanz,_Barbara_K._Rimer,_K._Viswanath]_Heal(BookFi.or.pdf

Godfrey, K. M., & Barker, D. J. (2000). Fetal nutrition and adult disease. *American Journal of Clinical Nutrition, 71*(5 Suppl), 1344S-1352S.

Godfrey, K. M., & Barker, D. J. (2001). Fetal programming and adult health. *Public Health Nutrition, 4*(2B), 611-624.

Grantham-McGregor, S., Cheung, Y. B., Cueto, S., Glewwe, P., Richter, L., Strupp, B., & International Child Development Steering Group. (2007). Developmental potential in the first 5 years for children in developing countries. *Lancet, 369*(9555), 60-70. doi:10.1016/S0140-6736(07)60032-4

Grebmer, K.V., Saltzman, A., Birol, E., Wiesmann, D., Prasai, N., Yin, S. , . . . Sonntag, A. . (2014). *2014 Global Hunger Index: The Challenge of Hidden Hunger*. Retrieved from http://reliefweb.int/sites/reliefweb.int/files/resources/ghi14.pdf

Groot, Wim, & van den Brink, Henriëtte Maassen. (2002). Age and education difference in marriages and their effects on life satisfaction. *Journal of Happiness Studies, 3*, 153-165. doi:doi:10.1023/A:1019673927286

Guha-Khasnobis, Basudeb, & Hazarika, Gautam. (2006). *Women's status and children's food security in Pakistan - WIDER Discussion Papers* (2006/03). Retrieved from www.wider.unu.edu/sites/default/files/dp2006-03.pdf

Habicht, J. P., Victora, C. G., & Vaughan, J. P. (1999). Evaluation designs for adequacy, plausibility and probability of public health programme performance and impact. *International Journal of Epidemiology, 28*(1), 10-18. doi:10.1093/ije/28.1.10

Haddad, L. (2000). A conceptual framework for assessing agriculture–nutrition linkages. *Food and Nutrition Bulletin, 21*(4), 367-373. doi:DOI: 10.1177/156482650002100405

Hadley, C., Tessema, F., & Muluneh, A. T. (2012). Household food insecurity and caregiver distress: equal threats to child nutritional status? *American Journal of Human Biology : The Official Journal of the Human Biology Council, 24*(2), 149-157. doi:10.1002/ajhb.22200

Hailu, Israel , Kidane, Amanuel, Kovach, Tara, Lemma, Ferew, Sethuraman, Kavita, Sommerfelt, A. Elisabeth;, & Teka, Telahun. (2013). *A tool to support nutrition advocacy in Ethiopia: Ethiopia PROFILES 2012 estimates* Addis Ababa, Ethiopia & Washigton, DC: Food and Nutrition Technical Assistance III Project (FANTA)/FHI 360 and Federal Ministry of Health, Ethiopia

HarvestPlus. (2016). Nutrition. Retrieved from http://www.harvestplus.org/what-we-do/nutrition

Hausmann, Ricardo , Tyson, Laura D. , & Zahidi, Saadia. (2010). *The global gender gap report 2010*. Geneva, Switzerland: World Economic Forum.

Hochbamum, G. M. (1956). Why people seek diagnostic x-rays. *Public Health Reports, 71*(4), 377-380.

Horton, R. (2008). Maternal and child undernutrition: an urgent opportunity. *Lancet, 371*(9608), 179. doi:10.1016/S0140-6736(07)61869-8

Howe, L. D., Hargreaves, J. R., & Huttly, S. R. (2008). Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerg Themes Epidemiol, 5*, 3. doi:10.1186/1742-7622-5-3

IDRC. (2014). *Promoting adoption of chickpea technologies in Southern Ethiopia (CIFSRF)*. Retrieved from https://www.idrc.ca/en/project/promoting-adoption-chickpea-technologies-southern-ethiopia-cifsrf

IFPRI. (2010). *Pulses value chain potential in Ethiopia: Constrains and opportunities for enhancing exports*. Retrieved from https://ethiopianagriculture.files.wordpress.com/2010/11/ethiopia-pulses-value-chain-diagnostic-july-20101.pdf

Issel, L. M. (2009). *Health Program Planning and evaluation: A practical Systematic Approach for Community Health* (Vol. second). Boston, MA: Jones and Bartlett.

IZiNCG, Brown, K. H., Rivera, J. A., Bhutta, Z., Gibson, R. S., King, J. C., & Hotz, C. (2004). International Zinc Nutrition Consultative Group (IZiNCG) technical document #1: Assessment of the risk of zinc deficiency in populations and options for its control. *Food Nutrition Bulletin*, *25*(1 Suppl 2), S99-203.

Jayne, T. S., & Molla, D. (1995). *Food Security Research Project, Working Paper 2: Toward A Research Agenda to Promote Access to Food by Vulnerable Groups through Food Transfer Arrangements and Food Markets*. Retrieved from http://aec.msu.edu/fs2/ethiopia/wp2.pdf

Jin, M., & Iannotti, L. L. (2014). Livestock production, animal source food intake, and young child growth: the role of gender for ensuring nutrition impacts. *Social Science and Medicine, 105*, 16-21. doi:10.1016/j.socscimed.2014.01.001

Jones, G., Steketee, R. W., Black, R. E., Bhutta, Z. A., & Morris, S. S. (2003). How many child deaths can we prevent this year? *Lancet, 362*(9377), 65-71. doi:10.1016/s0140-6736(03)13811-1

Karlberg, J. (1989). A biologically-oriented mathematical model (ICP) for human growth. *Acta Paediatrica Scandinavica. Supplement, 350*, 70-94.

Kebebu, A., Whiting, S.J., Dahl, W.J., Henry, C.J., & Abegaz, K. (2013). Formulation of a complementary food fortified with broad beans (Vicia faba) in southern Ethiopia. *African J of Food, Agriculture, Nutrition and Development, 13*(3), 7789-7803.

Kebebush, Gebre-Michael. (2011). *Assessment of Nutritional Status and Pulse Consumption Patterns Among Adolescent Girls in Huletegna Choroko Kebele, Halaba Special Woreda, Southern Ethiopia.* (Master of Science), Hawassa University, Hawassa, Ethiopia.

Kedir Teji Roba, O'Connor, Thomas P., Belachew, Tefera, & O'Brien, Nora M. . (2016). Infant and Young Child Feeding (IYCF) Practices among mothers of children aged 6–23 months in two agro-ecological zones of rural Ethiopia. *International Journal of Nutrition and Food Sciences, 5*(3), 185-194. doi:10.11648/j.ijnfs.20160503.16

Kennedy, G., Ballard, T., & Dop, M.C. (2011). *Guidelines for measuring household and individual dietary diversity*. Rome, Italy Food and Agriculture Organization of the United Nations.

Kenya National Bureau of Statistics, Ministry of Health, National AIDS Control Council, Kenya Medical Research Institute, & National Council for Population and Development. (2015). *Kenya Demographic and Health Survey 2014: Key Indicators*. Nairobi, Kenya: Kenya National Bureau of Statistics.

Kenya National Bureau of Statistics (KNBS), & ICF Macro. (2010). *Kenya Demographic and Health Survey 2008-09*. Nairobi, Kenya & Calverton, MD: KNBS and ICF Macro.

Keogh-Brown, M., Bachmann, M., Shepstone, L., Hewitt, C., Howe, A., Ramsay, C., . . . Campbell, M. (2007). Contamination in trials of educational interventions. *Health Technology Assessment, 11*(43), iii, ix-107. doi:10.3310/hta11430

Kimani-Murage, E. W., Schofield, L., Wekesah, F., Mohamed, S., Mberu, B., Ettarh, R., . . . Ezeh, A. (2014). Vulnerability to food insecurity in urban slums: experiences from Nairobi, Kenya. *Journal of Urban Health, 91*(6), 1098-1113. doi:10.1007/s11524-014-9894-3

Kind, K. L., Moore, V. M., & Davies, M. J. (2006). Diet around conception and during pregnancy--effects on fetal and neonatal outcomes. *Reprod Biomed Online, 12*(5), 532-541. doi:10.1016/S1472-6483(10)61178-9

Kramer, M. S. (1987a). Determinants of low birth weight: methodological assessment and meta-analysis. *Bulletin of the World Health Organization, 65*(5), 663-737.

Kramer, M. S. (1987b). Intrauterine growth and gestational duration determinants. *Pediatrics, 80*(4), 502-511.

Kramer, M. S., & Kakuma, R. (2003). Energy and protein intake in pregnancy. *Cochrane Database Systematic Review, 4*(4), CD000032. doi:10.1002/14651858.CD000032

Kravdal, Øystein, & Kodzi, Ivy. (2011). Children's stunting in sub-Saharan Africa: Is there an externality effect of high fertility? *Demographic Research, 25*(18), 565-594. doi:10.4054/DemRes.2011.25.18

Krebs, N. F., Mazariegos, M., Chomba, E., Sami, N., Pasha, O., Tshefu, A., . . . Hambidge, K. M. (2012). Randomized controlled trial of meat compared with multimicronutrient-fortified cereal in infants and toddlers with high stunting rates in diverse settings. *American Journal of Clinical Nutrition, 96*(4), 840-847. doi:10.3945/ajcn.112.041962

Kusin, J. A., Kardjati, S., Houtkooper, J. M., & Renqvist, U. H. (1992). Energy supplementation during pregnancy and postnatal growth. *Lancet, 340*(8820), 623-626.

Lartey, A. (2008). Maternal and child nutrition in sub-Saharan Africa: challenges and interventions. *Proceedings of the Nutrition Society, 67*(1), 105-108. doi:10.1017/S0029665108006083

Lombamo, Getahun Ersino, Henry, Carol J, Regassa, Nigatu, & Zello, Gordon A. (2016). Child stunting and maternal undernutrition in two rural Ethiopian communities five years after the initiation of the National Nutrition Program. *The FASEB Journal, 30*(1 Supplement), 669.664.

Lombamo, Getahun Ersino, Henry, Carol J. , & Zello, Gordon A. . (2015). Dietary Intakes of Fe, Zn and Protein and Anthropometric Measures of Mothers and Children Living in Pulse or Cereal-Growing Rural Communities of Ethiopia. *European Journal of Nutrition & Food Safety, 5*(5). doi:10.9734/EJNFS/2015/21221

Lopez, A. D., Mathers, C. D., Ezzati, M., Jamison, D. T., & Murray, C. J. (2006). Global and regional burden of disease and risk factors, 2001: Systematic analysis of population health data. *Lancet, 367*(9524), 1747-1757. doi:10.1016/S0140-6736(06)68770-9

Lytle, Leslie A. (2005). Nutrition education, behavioral theories, and the scientific method: Another viewpoint. *Journal of Nutrition Education and Behavior, 37*(2), 90-93. doi:10.1016/s1499-4046(06)60021-3

Martorell, R., & Zongrone, A. (2012). Intergenerational influences on child growth and undernutrition. *Paediatric and Perinatal Epidemiology, 26 Suppl 1*, 302-314. doi:10.1111/j.1365-3016.2012.01298.x

Masibo, P. K., & Makoka, D. (2012). Trends and determinants of undernutrition among young Kenyan children: Kenya Demographic and Health Survey; 1993, 1998, 2003 and 2008-2009. *Public Health Nutrition, 15*(9), 1715-1727. doi:10.1017/S1368980012002856

Masset, E., Haddad, L., Cornelius, A., & Isaza-Castro, J. (2012). Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ, 344*(Report), d8222. doi:10.1136/bmj.d8222

Matanda, D. J., Mittelmark, M. B., & Kigaru, D. M. (2014). Child undernutrition in Kenya: trend analyses from 1993 to 2008-09. *BMC Pediatrics, 14*, 5. doi:10.1186/1471-2431-14-5

Maxmen, A. (2014). Solving hunger in Ethiopia by turning to native crops, Newspaper Article. *Newsweek (Tech & Science)*. Retrieved from http://www.newsweek.com/2014/12/26/solving-hunger-ethiopia-turning-native-crops-291558.html

McAlister, A. L., Perry, C. L., & Parcel, G. S. (2008). How individuals, environments, and health behaviors interact: Social Cognitive Theory. In K. Glanz, B. K. Rimer, & K. Viswanath (Eds.), *Health behavior and health education: Theory, research, and practice* (Fourth ed., pp. 169-188). San Francisco, CA: Jossey-Bass A Wiley Imprint.

McCawley, P. F. (2001). *The logic model for program planning and evaluation*. Retrieved from http://www.cals.uidaho.edu/edcomm/detail.asp?IDnum=798

McCormick, M. C. (1985). The contribution of low birth weight to infant mortality and childhood morbidity. *New England Journal of Medicine, 312*(2), 82-90. doi:10.1056/NEJM198501103120204

McDonald, C. M., McLean, J., Kroeun, H., Talukder, A., Lynd, L. D., & Green, T. J. (2015). Household food insecurity and dietary diversity as correlates of maternal and child undernutrition in rural Cambodia. *European Journal of Clinical Nutrition, 69*(2), 242-246. doi:10.1038/ejcn.2014.161

McLean, E., Cogswell, M., Egli, I., Wojdyla, D., & de Benoist, B. (2009). Worldwide prevalence of anemia, WHO Vitamin and Mineral Nutrition Information System, 1993-2005. *Public Health Nutrition, 12*(4), 444-454. doi:10.1017/S1368980008002401

McNulty, J. . (2013). *Challenges and issues in nutrition education. Rome: Nutrition Education and Consumer Awareness Group*. Rome, Italy: Food and Agriculture Organization of the United Nations.

Mesfin, Addisalem, Henry, Carol, Girma, Meron, & Whiting, Susan J. (2016). Use of pulse crops in complementary feeding of 6-23-month-old infants and young children in Taba Kebele, Damot Gale District, Southern Ethiopia. *Journal of Public Health in Africa, 6*(1), 357. doi:10.4081/jphia.2015.357

Meshram, I.I., Kodavanti, M. R., Chitty, G. R., Manchala, R., Kumar, S., Kakani, S. K., . . . Ginnela Narsimhachary Veera, B. (2013). Influence of Feeding Practices and Associated Factors on the Nutritional Status of Infants in Rural Areas of Madhya Pradesh State, India. *Asia-Pacific Journal of Public Health*. doi:10.1177/1010539513486174

Meshram, II, Arlappa, N., Balakrishna, N., Laxmaiah, A., Mallikarjun Rao, K., Gal Reddy, Ch, . . . Brahmam, G. N. (2012). Prevalence and determinants of undernutrition and its trends among pre-school tribal children of Maharashtra State, India. *Journal of Tropical Pediatrics, 58*(2), 125-132. doi:10.1093/tropej/fmr035

Meshram, II, Balakrishna, N., Arlappa, N., Mallikarjun Rao, K., Laxmaiah, A., & Brahmam, G. N. (2014). Prevalence of undernutrition, its determinants, and seasonal variation among tribal preschool children of Odisha state, India. *Asia-Pacific Journal of Public Health, 26*(5), 470-480. doi:10.1177/1010539512441492

Micronutrient Initiative (MI). (2009). *Investing in the Future: A United Call to Action on Vitamin and Mineral Deficiencies-Global Report 2009*. Retrieved from http://www.unitedcalltoaction.org/documents/Investing_in_the_future.pdf

Miese-Looy, Germaine, Rollings-Scattergood, Jessica, & Yeung, Anna (2008). Long-term health consequences of poor nutrition during pregnancy. *Studies by Undergraduate Researchers at Guelph, 1*(2). https://journal.lib.uoguelph.ca/index.php/surg/rt/printerFriendly/421/666

Ministry of Finance and Economic Development. (2010). *Growth and transformation plan 2010/11-2014/15: Volume II Policy matrix* Addis Ababa, Ethiopia: Federal Democratic Republic of Ethiopia Retrieved from https://www.imf.org/external/pubs/ft/scr/2011/cr11305.pdf.

Moser, Caroline O. N. (1989). Gender planning in the third world: Meeting practical and strategic gender needs. *World Development, 17*(11), 1799-1825. doi:10.1016/0305-750x(89)90201-5

Mosse, J.C. (1993). *Half the World Half a Chance: An introduction to gender and development*. Oxford, England: Oxfam.

Mostafa, K. S. (2011). Socio-economic determinants of severe and moderate stunting among under-five children of rural Bangladesh. *Malaysia Journal of Nutrition, 17*(1), 105-118. http://nutriweb.org.my/publications/mjn0017_1/Mostafa277(10)(edSP)(RV).pdf

Mucha, Noreen (2012). *Enabling and equipping women to improve nutrition: Briefing paper*. Retrieved from http://www.bread.org/file/1033/download?token=-943QiOI.

Muchenje, Francis, & Goronga, Pedzisai (2013). Education and the Revitalisation of Indigenous Knowledge Systems in Africa: A Paradigm Shift in Curriculum Content. *International Journal of Social Sciences and Education, 3*(4), 886-894.

Muehlhoff, Ellen, & Sherman, Jane. (2016). Nutrition education. In N. J. Temple & N. Steyn (Eds.), *Community Nutrition Textbook for Developing Countries* (pp. 285-308).

Athabasca University & UNISA, South Africa: AU Press, Athabasca University and UNISA Press, University of South Africa.

Mulualem, D., Henry, C. J., Berhanu, G., & Whiting, S. J. (2016). The effectiveness of nutrition education: Applying the Health Belief Model in child-feeding practices to use pulses for complementary feeding in Southern Ethiopia. *Ecology of Food and Nutrition, 55*(3), 308-323. doi:10.1080/03670244.2016.1161617

Mulugeta, Frehiwot (2009). *Lentil production, supply, demand and marketing issues in Ethiopia*. Retrieved from http://www.ecea.gov.et/doc/Lentil%20Crop%20Profile.pdf

Na, M., Jennings, L., Talegawkar, S. A. , & Ahmed, S. . (2015). Associationbetweenwomen'sempowermentandinfantandchild feeding practices in sub-Saharan Africa: an analysis of Demographic and Health Surveys. *Public Health Nutrition, 18*(17), 3155-3165. doi:https://doi.org/10.1017/S1368980015002621

Nagpaul, P.S. (1999). Guide to advanced data analysis using IDAMS Software. Retrieved from http://www.unesco.org/webworld/idams/advguide/TOC.htm

Nega, B. , Adenew, B., & Gebre Sellasie, S. . (2003). Current land policy issues in Ethiopia. In P. Groppo (Ed.), *2003/3 Land Reform: Land settlement and cooperatives - special edition*. Rome, Italy FAO & World Bank.

Negash, C., Whiting, S. J., Henry, C. J., Belachew, T., & Hailemariam, T. G. (2015). Association between maternal and child nutritional status in Hula, rural southern Ethiopia: A Cross sectional study. *PloS One, 10*(11), e0142301. doi:10.1371/journal.pone.0142301

Negash, Canaan, Belachew, Tefera, Henry, Carol J., Kebebu, Afework, Abegaz, Kebede, & Whiting, Susan J. (2014). Nutrition education and introduction of broad bean-based complementary food improves knowledge and dietary practices of caregivers and nutritional status of their young children in Hula, Ethiopia. *Food Nutrition Bulletin, 35*(4), 480-486. doi:10.1177/156482651403500409

Neufeld, L. M., Haas, J. D., Grajeda, R., & Martorell, R. (2004). Changes in maternal weight from the first to second trimester of pregnancy are associated with fetal growth and infant length at birth. *The American Journal of Clinical Nutrition*, *79*(4), 646-652.

Neumann, C. G., & Harrison, G. G. (1994). Onset and evolution of stunting in infants and children. Examples from the Human Nutrition Collaborative Research Support Program. Kenya and Egypt studies. *European Journal of Clinical Nutrition, 48 Suppl 1*, S90-102.

Nguyen, P. H., Avula, R., Ruel, M. T., Saha, K. K., Ali, D., Tran, L. M., . . . Rawat, R. (2013). Maternal and child dietary diversity are associated in Bangladesh, Vietnam, and Ethiopia. *The Journal of Nutrition, 143*(7), 1176-1183. doi:10.3945/jn.112.172247 [doi]

Nierenberg, D. (2013). How Enset can save Ethiopia. *Thought Leaders*. Retrieved from http://thoughtleader.co.za/daniellenierenberg/2013/07/28/how-enset-can-save-ethiopia/

Nukala, A. (2012). Chickpeas undergo a revolution: A better bean is boosting Ethiopia's economy. *Scientific American, 307(3)*.

Oberdabernig, D. A. . (2010). *The Effects of Structural Adjustment Programs on Poverty and Income Distribution*. Retrieved from http://wiiw.ac.at/the-effects-of-structural-adjustment-programs-on-poverty-and-income-distribution-e-15.html

Odora Hoppers, Catherine A. (2002). Indigenous knowledge systems: A profound challenge for human development in the twenty-first century. In Catherine A. Odora Hoppers (Ed.), *Indigenous Knowledge and the Integration of Knowledge Systems: Towards a Philosophy of Articulation*. Claremont, South Africa: New Africa Education.

Odora Hoppers, Catherine A. (2008). *Life Long Learning in Africa: Lessons, Experiences And Opportunities from Cultural and Cognitive Justice* Paper presented at the The Session of the 21st Century Talks on the Theme "Lifelong learning for all: how long to get there?" UNESCO document retrieved from http://unesdoc.unesco.org/images/0016/001636/163618e.pdf

Ofuya, Z.M., & V., Akhidue. (2005). The role of pulses in human nutrition: A review. *Journal of Applied Sciences and Environmental Managment, 9*(3), 99-104.

Oniang'o, Ruth , & Mukudi, Edith (2002). Nutrition and gender. In UN ACC Sub-Committee on Nutrition (Ed.), *Nutrition: A foundation for development-why practitioners in Development Should Integrate Nutrition*: United Nations Administrative Committee on Coordination/Subcommittee on Nutrition.

Ota, E., Haruna, M., Suzuki, M., Anh, D. D., Tho le, H., Tam, N. T., . . . Yanai, H. (2011). Maternal body mass index and gestational weight gain and their association with perinatal outcomes in Viet Nam. *Bulletin of the World Health Organization, 89*(2), 127-136. doi:10.2471/BLT.10.077982

Pan American Health Organization, & WHO. (2003). *Guiding principles for complementary feeding of the breastfed child*: PAHO and World Health Organization.

Patel, R. (2007). *The World Bank and Agriculture: A Creatical Review of the World Bank's World Development Report 2008*. Retrieved from http://rajpatel.org/wp-content/uploads/2009/11/actionaid.pdf

Paudel, R., Pradhan, B., Wagle, R.R., Pahari, D.P., & Onta, S.R. (2012). Risk Factors for Stunting Among Children: A Community Based Case Control Study in Nepal. *Kathmandu Univ Med J, 39*(3), 18-24.

Pfeiffer, Wolfgang H., & McClafferty, Bonnie. (2007). HarvestPlus: Breeding Crops for Better Nutrition. *Crop Science, 47*(Supplement_3), S-88. doi:10.2135/cropsci2007.09.0020IPBS

Prasad, A. S., Schulert, A. R., Miale, A., Jr., Farid, Z., & Sandstead, H. H. (1963). Zinc and iron deficiencies in male subjects with dwarfism and hypogonadism but without ancylostomiasis, schistosomiasis or severe anemia. *The American Journal of Clinical Nutrition, 12*, 437-444.

Pratley, P. (2016). Associations between quantitative measures of women's empowerment and access to care and health status for mothers and their children: A systematic review of evidence from the developing world. *Social Science and Medicine, 169*, 119-131. doi:10.1016/j.socscimed.2016.08.001

Prochaska, J. Q., & DiClemente, C. C. . (1983). Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology, 51*(3), 390-395.

Pulse Canada. (2012). *Fact Sheets: Protein Quality of Cooked Pulses (PDCAAS Method)*. Retrieved from http://www.pulsecanada.com/uploads/ff/28/ff280f2f10206d5a53a241ef6e2e2d25/USA_PC_protein_fact_sheet_p6.pdf

Pulse Canada. (2016). Food and Health: Nutritional Benefits. Retrieved from http://www.pulsecanada.com/food-health/nutritional-benefits

Rah, J. H., Akhter, N., Semba, R. D., de Pee, S., Bloem, M. W., Campbell, A. A., . . . Kraemer, K. (2010). Low dietary diversity is a predictor of child stunting in rural Bangladesh. *European Journal of Clinical Nutrition, 64*(12), 1393-1398. doi:10.1038/ejcn.2010.171

Raingruber, B. (2014). Health Promotion Theories- *Contemporary health promotion in nursing practice* (pp. 53-94). Burlington, MA: Jones & Bartlett, LLC.

Rajaratnam, J. K., Marcus, J. R., Flaxman, A. D., Wang, H., Levin-Rector, A., Dwyer, L., . . . Murray, C. J. (2010). Neonatal, postneonatal, childhood, and under-5 mortality for 187 countries, 1970-2010: a systematic analysis of progress towards Millennium Development Goal 4. *Lancet, 375*(9730), 1988-2008. doi:10.1016/S0140-6736(10)60703-9

Ramakrishnan, Usha. (2004). Nutrition and low birth weight: from research to practice. *American Journal of Clinical Nutrition, 79*, 17-21.

Rebello, C. J., Greenway, F. L., & Finley, J. W. (2014). A review of the nutritional value of legumes and their effects on obesity and its related co-morbidities. *Obesity Reviews, 15*(5), 392-407. doi:10.1111/obr.12144

Regassa, N. (2011). Small holder farmers coping strategies to household food insecurity and hunger in Southern Ethiopia. *Ethiopian Journal of Environmental Studies and Management, 4*(1). doi:10.4314/ejesm.v4i1.5

Regassa, N., & Stoecker, B. J. (2012a). Contextual risk factors for maternal malnutrition in a food-insecure zone in southern Ethiopia. *Journal of Biosocial Science, 44*(5), 537-548. doi:10.1017/S002193201200017X

Regassa, N., & Stoecker, B. J. (2012b). Household food insecurity and hunger among households in Sidama district, southern Ethiopia. *Public Health Nutrition, 15*(7), 1276-1283. doi:10.1017/S1368980011003119

Regassa, Nigatu, & Tsegaye, Gete. (2013). *Analysis of pulse production and management practices from gender perspectives: a study of four rural districts in SNNPR and Oromiya Regions of Ethiopia*. Hawassa University. Retrieved from http://hdl.handle.net/10625/53714

Reurings, M., Vossenaar, M., Doak, C. M., & Solomons, N. W. (2013). Stunting rates in infants and toddlers born in metropolitan Quetzaltenango, Guatemala. *Nutrition, 29*(4), 655-660. doi:10.1016/j.nut.2012.12.012

Rizkalla, S. W., Bellisle, F., & Slama, G. (2002). Health benefits of low glycaemic index foods, such as pulses, in diabetic patients and healthy individuals. *British Journal of Nutrition, 88 Suppl 3*, S255-262. doi:10.1079/BJN2002715

Roba, A. C., Gabriel-Micheal, K., Zello, G. A., Jaffe, J., Whiting, S. J., & Henry, C. J. (2015). A low pulse food intake may contribute to the poor nutritional status and low dietary intakes of adolescent girls in rural southern ethiopia. *Ecology of Food and Nutrition, 54*(3), 240-254. doi:10.1080/03670244.2014.974593

Ronsmans, C., Holtz, S., & Stanton, C. (2006). Socioeconomic differentials in caesarean rates in developing countries: a retrospective analysis. *Lancet*, *368*(9546), 1516-1523. doi:10.1016/S0140-6736(06)69639-6

Rosenstock, I. M. (2005). Why People Use Health Services. *Milbank Quarterly, 83*(4), Online-only-Online-only. doi:10.1111/j.1468-0009.2005.00425.x

Ruel, M. T., Alderman, H., Maternal, & Child Nutrition Study, Group. (2013). Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet, 382*(9891), 536-551. doi:10.1016/S0140-6736(13)60843-0; 10.1016/S0140-6736(13)60843-0

Satzinger, F., Bezner Kerr, R., & Shumba, L. (2009). Intergenerational participatory discussion groups foster knowledge exchange to improve child nutrition and food security in northern Malawi. *Ecology of Food and Nutrition, 48*(5), 369-382. doi:10.1080/03670240903170483

Save the Children UK. (2009). *Ethiopian National Nutrition Strategy: Review and Analysis of Progress and Gaps: One Year On*. Retrieved from http://www.fao.org/fileadmin/user_upload/drought/docs/Ethiopia_National_Nutrition_Strategy_Final_Report.pdf

Selinus, R. (2010). *The Traditional Foods of the Central Ethiopian Highlands (research report no. 7)*. Retrieved from https://ethnomed.org/clinical/nutrition/the-traditional-foods-of-the-central-ethiopian

Settee, P. (1999). *Honouring Indigenous Science as a Means of Ensuring Scientific Responsibility* (Master of Education), University of Manitoba, Winnipeg, Manitoba. Retrieved from http://sap-water-project.ca/sites/default/files/myDocuments/Honouring-Indigenous-Knowledge.pdf

Sewnet, Y. (2015). Causes and coping mechanisms of food insecurity in rural Ethiopia. *Agricultural and Biology Journal of North America, 6*(5), 123-133. doi:10.5251/abjna.2015.6.5.123.133

Seyoum, Alemayehu, Dorosh, Paul, & Asrat, Sinafikeh (2011). *Crop Production in Ethiopia: Regional Patterns and Trends. Development Strategy and Governance Division, Strategy*

Support Program II (16). Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.190.9513&rep=rep1&type=pdf

Shah, A. (2013, March 24,). Structural adjustment - a major cause of poverty. Retrieved from http://www.globalissues.org/article/3/structural-adjustment-a-major-cause-of-poverty

Shediac-Rizkallah, M. C., & Bone, L. R. (1998). Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy. *Health Education Research, 13*(1), 87-108.

Shinsugi, C., Matsumura, M., Karama, M., Tanaka, J., Changoma, M., & Kaneko, S. (2015). Factors associated with stunting among children according to the level of food insecurity in the household: a cross-sectional study in a rural community of Southeastern Kenya. *BMC Public Health, 15*(1), 441-015-1802-1806. doi:10.1186/s12889-015-1802-6

Smith, M., Pointing, J., & Maxwell, S. (1992). Household food security, concepts and definitions: An Annotated Bibliography. In S. Maxwell & T.R. Frankerberger (Eds.), *Household Food Security: Concepts, Indicators, Measurements- A Technical Review*. New York, NY and Rome, Italy: United Nation's Children's Fund - International Fund for Agricultural Development.

Stewart, M. K., Colley, D., Huff, A., Felix, H., Shelby, B., Strickland, E., . . . McCabe-Sellers, B. (2009). Participatory development and implementation of a community research workshop: experiences from a community-based participatory research partnership. *Progress in community health partnerships: research, education, and action, 3*(2), 165-178. doi:10.1353/cpr.0.0068

Stokols, D. . (1996). Translating social ecological theory into guidelines for community health promotion. *American Journal of Health Promotion, 10*(4), 282-298.

Storck, H., Emana, B., Adinew, B., Borowiecki, A., & W/Hawariat, S. (1991). *Farming systems and farm management practices of smallholders in the Hararghe highlands: A baseline survey* (Vol. 11). F.R, Germany: Wissenschaftsverlag, Vauk, Kiel.

SUN Country Network. (2015). Ethiopia commits to ending under-nutrition by 2030 with the Seqota Declaration [Press release]. Retrieved from http://scalingupnutrition.org/news/ethiopia-commits-to-ending-under-nutrition-by-2030-with-the-seqota-declaration/

Swindale, Anne, & Paula, Bilinsky. (2006). *Household Dietary Diversity Score (HDDS) for measurement of household food access: Indicator guide (v.2)*. Washington, DC: FHI 360 & FANTA.

Tadele, N., Habta, F., Akmel, D., & Deges, E. (2016). Knowledge, attitude and practice towards exclusive breastfeeding among lactating mothers in Mizan Aman town, Southwestern Ethiopia: descriptive cross-sectional study. *Internaltional Breastfeeding Journal*, *11*(3), 3. doi:10.1186/s13006-016-0062-0

Tamiru, D., Belachew, T., Loha, E., & Mohammed, S. (2012). Sub-optimal breastfeeding of infants during the first six months and associated factors in rural communities of Jimma Arjo Woreda, Southwest Ethiopia. *BMC Public Health, 12*, 363. doi:10.1186/1471-2458-12-363

Tariku, B., Whiting, S. J., Mulualem, D., & Singh, P. (2015). Application of the Health Belief Model to Teach Complementary Feeding Messages in Ethiopia. *Ecology of Food and Nutrition*, *54*(5), 572-582. doi:10.1080/03670244.2015.1049344

Teklehaimanot, T. (2015). Ethiopian Treasures: Food. Retrieved from http://www.ethiopiantreasures.co.uk/pages/culture.htm

Teshome, Girma, Kassa, Belay, Emana, Bezabih, & Haji, Jema. (2013). Patterns and Determinates of Farm Households' Investment in Rural Ethiopia: The Case of East Hararghe Zone, Oromia National Regional State. *American Journal of Economics, 3*(4), 191-198. doi:10.5923/j.economics.20130304.02

Tessema, M., Belachew, T., & Ersino, G. (2013). Feeding patterns and stunting during early childhood in rural communities of Sidama, South Ethiopia. *Pan African Medical Journal, 14*, 75. doi:10.11604/pamj.2013.14.75.1630

Thavarajah, D., Thavarajah, P., Sarker, A., & Vandenberg, A. (2009). Lentils (Lens culinaris Medikus Subspecies culinaris): a whole food for increased iron and zinc intake. *Journal of Agricultural and Food Chemistry, 57*(12), 5413-5419. doi:10.1021/jf900786e

The Ethiopian Orthodox Tewahedo Church. (2003, Sep. 9, 2016). The Ethiopian Orthodox Tewahedo Church Faith and Order. Retrieved from http://www.ethiopianorthodox.org/english/indexenglish.html

The Oakland Institute. (2015). *We say the land is not yours: Breaking the silence against forced displacement in Ethiopia*. Oakland, CA: The Oakland Institute.

The United Nations Development Programme. (2005). *Human Development Report 2005: International cooperation at a crossroads: Aid, trade and security in an unequal world*. New York, NY: The United Nations Development Programme.

Tse, W. Y., Hindmarsh, P. C., & Brook, C. G. (1989). The infancy-childhood-puberty model of growth: clinical aspects. *Acta paediatrica Scandinavica.Supplement, 356*, 38-43; discussion 44-35.

Uganda Bureau of Statistics (UBOS), & ICF International Inc. (2012). *Uganda Demographic and Health Survey 2011*. Kampala, Uganda & Calverton, MD: UBOS and ICF Internaltional Inc.

Umeta, M., West, C. E., Haidar, J., Deurenberg, P., & Hautvast, J. G. (2000). Zinc supplementation and stunted infants in Ethiopia: a randomised controlled trial. *Lancet, 355*(9220), 2021-2026. doi:10.1016/S0140-6736(00)02348-5

Umeta, M., West, C. E., Verhoef, H., Haidar, J., & Hautvast, J. G. (2003). Factors associated with stunting in infants aged 5-11 months in the Dodota-Sire District, rural Ethiopia. *Journal of Nutrition, 133*(4), 1064-1069.

UN-HABITAT. (2008). *Land registration in Ethiopia: Early impacts on women*. Retrieved from http://siteresources.worldbank.org/NEWS/Resources/land_eegistration_in_ethiopia.pdf

UN. (2015). *The Millennium Development Goals Report: Sub-Saharan Africa*. Retrieved from http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/backgrounders/MDG%202015%20PR%20Bg%20SSA.pdf

UN Data. (2012). United Nations data: A world of information; total fertility rate (TFR). Retrieved from http://data.un.org/Data.aspx?d=SOWC&f=inID%3A127

UN Standing Committee on Nutrition. (2011). *The 6th report on the world nutrition situation: progress in nutrition*. Retrieved from http://www.unscn.org/files/Publications/RWNS6/report/SCN_report.pdf

UNICEF. (1990). *Strategy for improved nutrition of children and women in developing countries: A UNICEF policy review*. New York, NY: United Nations International Children's Emergency Fund

UNICEF. (2004). *Progress For Children: A child survival report card*. Retrieved from http://www.unicef.org/progressforchildren/2004v1/pdf/pfc_eng.pdf

UNICEF. (2009). *Tracking progress on child and maternal nutrition: A survival and development Priority*. New York, NY: United Nations Children's Fund.

UNICEF. (2012). *Information publication: Major goals for children and development in the 1990s*. Retrieved from http://www.unicef.org/wsc/goals.htm

UNICEF, WHO, UNESCO, UNFPA, UNDP, UNAIDS, . . . World Bank. (2010). *Facts for Life* (Fourth ed.). New York, NY: United Nations Children's Fund.

UNICEF, WHO, & World Bank. (2015). *Levels and trends in child malnutrition: UNICEF – WHO – World Bank Group joint child malnutrition estimates: Key findings of the 2015 edition*. Retrieved from http://www.unicef.org/media/files/JME_2015_edition_Sept_2015.pdf

United Nations. (2012). Millennium Development Goals Indicators: The Official United Nations Site for MDG indicators. Retrieved from http://mdgs.un.org/unsd/mdg/Default.aspx/ and http://mdgs.un.org/unsd/mi/wiki/MainPage.ashx

United Nations. (2016). Sustainable Development Goals: 17 Goals to Transform Our World. Retrieved from http://www.un.org/sustainabledevelopment/hunger/

United Nations Development Program. (2011). *Human Development Report 2011: Sustainability and Equity: A Better Future for All*. New York, NY: United Nations Development Program.

United Nations Development Programme. (2014). *Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerability and Building Resilience*. New York, NY: United Nations Development Programme.

USDA Agricultural Research Service. (2014). USDA National Nutrient Database for Standard Reference, Release 27. from United States Department of Agriculture (USDA), Agricultural Research Services https://www.ars.usda.gov/northeast-area/beltsville-md/beltsville-human-nutrition-research-center/nutrient-data-laboratory/docs/usda-national-nutrient-database-for-standard-reference/

Van 't Riet, Jonathan, Ruiter, Robert A.C., Werrij, Marieke Q., & De Vries, Hein. (2009). What difference does a frame make? Potential moderators of framing effects and the role of self-efficacy *The European Health Psychologist, 11*, 26-29.

Veenstra, J. M., Duncan, A. M., Cryne, C. N., Deschambault, B. R., Boye, J. I., Benali, M., . . . Wright, A. J. (2010). Effect of pulse consumption on perceived flatulence and gastrointestinal function in healthy males. *Food Research International*, *43*(2), 553-559. doi:DOI 10.1016/j.foodres.2009.07.029

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., . . . Child Undernutrition Study Group. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *Lancet, 371*(9609), 340-357. doi:10.1016/S0140-6736(07)61692-4

Victora, C. G., Bahl, R., Barros, A. J., Franca, G. V., Horton, S., Krasevec, J., . . . Lancet Breastfeeding Series Group. (2016). Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *Lancet, 387*(10017), 475-490. doi:10.1016/S0140-6736(15)01024-7

Victora, C. G., Barros, A. J. D., Fuchs, S. C., de Francisco, A., Morris, J., Hall, A. J., . . . Role, WHO Collaborative Study Team. (2000). Effect of breastfeeding on infant and child mortality due to infectious diseases in less developed countries: A pooled analysis. *Lancet, 355*(9202), 451-455. doi:10.1016/s0140-6736(00)82011-5

Victora, C.G., de Onis, M., Hallal, P.C., Blossner, M., & Shrimpton, R. (2010). Worldwide timing of growth faltering: revisiting implications for interventions. *Pediatrics, 125*(3), e473-480. doi:10.1542/peds.2009-1519

Villar, J., Valladares, E., Wojdyla, D., Zavaleta, N., Carroli, G., Velazco, A., . . . WHO global survey on maternal perinatal health research group. (2006). Caesarean delivery rates and pregnancy outcomes: The 2005 WHO global survey on maternal and perinatal health in Latin America. *Lancet, 367*(9525), 1819-1829. doi:10.1016/S0140-6736(06)68704-7

W.K. Kellogg Foundation. (2004a). *Evaluation Handbook: Philosophy and Expectations* Retrieved from http://www.observatorio.pt/download.php?id=599.

W.K. Kellogg Foundation. (2004b). *Using Logic Models to Bring Together Planning, Evaluation, and Action: Logic Model Development Guide*. Retrieved from http://www.smartgivers.org/uploads/logicmodelguidepdf.pdf

Wansink, B., & Pope, L. (2015). When do gain-framed health messages work better than fear appeals? *Nutrition Reviews, 73*(1), 4-11. doi:10.1093/nutrit/nuu010

Waterlow, J. C. (1988). *Observations on the Natural History of Stunting*. Paper presented at the Linear Growth Retardation in Less Developed Countries, NestldNutrition Workshop Series, Cha-am, Thailand. http://www.nestlenutritioninstitute.org/resources/library/Secured/workshop/Documents/Publication00014/npe_14_001.pdf

Waterlow, J.C. . (1993). Reflections on stunting. In C. Gopalan (Ed.), Recent Trends in Nutrition (pp. 18-34). Delhi: Oxford University Press. Retrieved from http://smith-gordon-publishing.co/pdf/Chapter-1-Reflections-on-stunting-JC-Waterlow.pdf.

Webb, P., & Kennedy, E. (2014). Impacts of agriculture on nutrition: nature of the evidence and research gaps. *Food and Nutrition Bulletin, 35*(1), 126-132.

Weinberger, K. (2005). Assessment of the nutritional impact of agricultural research: the case of mungbean in Pakistan. *Food Nutrition Bulletin, 26*(3), 287-294; discussion 295-286.

WHO. (1995). Maternal anthropometry and pregnancy outcomes: a WHO collaborative project. *Bulletin of the World Health Organization, 73*(Suppl), 1-98.

WHO. (1998). *Complementary feeding of young children in developing countries: A review of current scientific knowledge.* Retrieved from http://whqlibdoc.who.int/hq/1998/WHO_NUT_98.1.pdf.

WHO. (2008). *Indicators for assessing infant and young child feeding practices: Part-I Definitions, conclusions of a consensus meeting held 6-8 November 2007 in Washington, DC, USA.* Retrieved from http://www.who.int/nutrition/publications/infantfeeding/9789241596664/en/index.html

WHO. (2010). *Nutrition landscape information system (NLIS): Country profile indicators-interpretation guide.* Retrieved from http://www.who.int/nutrition/nlis_interpretation_guide.pdf

WHO. (2014). *Global nutrition targets 2025: Stunting policy brief.* Retrieved from http://www.who.int/nutrition/publications/globaltargets2025_policybrief_overview/en/

WHO. (2015). Global data base on child growth and malnutrition: Cut-off points and summary statistics. Retrieved from http://www.who.int/nutgrowthdb/about/introduction/en/index5.html

WHO. (2016). Maternal, newborn, child and adolescent health: Breastfeeding. Retrieved from http://www.who.int/maternal_child_adolescent/topics/child/nutrition/breastfeeding/en/index.html

WHO, FAO, & UNU. (2007). *Protein and amino acid requirements in human nutrition: Report of a Joint FAO/WHO/UNU Expert Consultation* (935). Retrieved from http://www.who.int/nutrition/publications/nutrientrequirements/WHO_TRS_935/en/

WHO, & UNICEF. (2003). *Global strategy for infant and young child feeding*. Retrieved from http://whqlibdoc.who.int/publications/2003/9241562218.pdf

WHO, & UNICEF. (2010). *Progress on sanitation and drinking-water: 2010 update* France: World Health Organization and UNICEF.

WHO, UNICEF, & 1000 Days. (2014). *Global nutrition targets 2025: Breastfeeding policy brief*. Retrieved from http://www.who.int/nutrition/publications/globaltargets2025_policybrief_breastfeeding/en/

WHO, UNU, & UNICEF. (2001). *Iron deficiency anemia: Assessment, prevention and control: A guide for programme managers*. Retrieved from http://www.who.int/nutrition/publications/en/ida_assessment_prevention_control.pdf

WHO Expert Committee on Physical Status. (1995). *Physical status: The use and interpretation of anthropometry. Report of a WHO Expert Committee*. Geneva, Switzerland: World Health Organization.

Wittman, H., & Desmarais, A. A. (2012). Food Sovereignty in Canada: Movement growing to control our own food and agriculture. Retrieved from https://www.policyalternatives.ca/publications/monitor/food-sovereignty-canada

World Bank. (2007). *From agriculture to nutrition: Pathways, synergies and outcomes*. Washington, DC: The International Bank for Reconstruction and Development / The World Bank.

World Bank. (2012). World Development Indicators: Ethiopia Data. Retrieved from http://go.worldbank.org/WA1RL12OL0

World Bank, FAO, & IFAD. (2009). *Gender in Agriculture: SourceBook*. Washington, DC: The International Bank for Reconstruction and Development / The World Bank.

Yang, H., & de Onis, M. (2008). Algorithms for converting estimates of child malnutrition based on the NCHS reference into estimates based on the WHO Child Growth Standards. *BMC Pediatrics, 8*(19). doi:12008186/1471-2431-8-19

Young, S. L., Plenty, A. H., Luwedde, F. A., Natamba, B. K., Natureeba, P., Achan, J., . . . Cohan, D. L. (2014). Household food insecurity, maternal nutritional status, and infant feeding practices among HIV-infected Ugandan women receiving combination antiretroviral therapy. *Maternal and child health journal, 18*(9), 2044-2053. doi:10.1007/s10995-014-1450-y

Appendices

Appendix A: Community-based nutrition education intervention on promotion of pulses as part of healthy meals in pulse growing rural communities (south Ethiopia)

1. Introduction to the intervention and rationale

The need to integrate nutrition education in existing agricultural and food security programs to impact nutrition in a population has been strongly recommended by various international agencies such as the Food and Agricultural Organization of the United Nations and World Bank. A brief review of literature and the rationale for conducting a community-based nutrition education intervention has been included in the literature review chapter (see section 2.9).

2. Objectives of the intervention

Under the third main objectives of ‘design, implement and assess effect of a community-based nutrition education intervention, that emphasises consumption of pulses as part of healthy meals, on the knowledge, attitude, practice (KAP) of mothers and nutritional status of mothers and children, the following more specific objectives tailored to the intervention were used:

- Improve the knowledge, attitude and practices of target community members on the important role of pulses (and foods made from pulses) in improving the diet and nutrition of the community
- Assess the contribution of integrating community-based nutrition education, in the existing food security and health initiative, to improving nutritional status in mothers and children

3. Target groups

Even though nutritional health outcome measures were evaluated only for mothers and their under five years of age children in the study areas, the intervention targeted the broader community including local nutrition educators who were trained to implement the intervention. Thus the target for the intervention were pulse growing rural communities which participated in the baseline study (including mothers and their husbands, the general community, Health Extension Workers, Agricultural Extension Workers, Research Assistants and Volunteer Health Promoters).

4. Conceptual framework of the intervention design

As part of the overall research design, Figure A1 shows the conceptual framework plan of how the intervention was going to be carried out in the target communities. In order to attribute outcomes of intervention to the services delivered through the intervention with higher level of confidence, a similar community that did not receive the services from the intervention (i.e., comparison community) was included. Data collected to meet the first two main objectives of the research project were used as baseline data for the intervention and comparison communities. Based on results from preliminary analysis of the baseline data, content of the nutrition education and the delivery approach were modified in order to best suit the intervention to the specific community. While the intervention community received the nutrition education, the comparison community was monitored for presence of any other intervention that might have a potential to mask the effect of the current intervention in the target. This type of intervention setup, i.e., between-groups quasi-experimental design, allows for a 'plausibility evaluation' of the intervention (i.e., higher confidence to attribute any positive outcomes to the service delivered through the intervention) as opposed to a within group design where end-line results are compared to baseline data of the same group (Gibson, 2005b; Habicht et al., 1999).

5. The intervention: Approach and strategies

As indicated earlier a community-based approach integrating elements of participation of community members was applied to deliver the intervention and initiate change of behaviour and action in the target community. Research evidence suggested that health programs that follow the traditional top-down, expert driven approach in delivery of services were not successful in terms of program impact and sustainability (Aubel & Samba-Ndure, 1996; Issel, 2009). Employing health program or intervention approaches that integrate active involvement of communities to address their own health issues is vital prerequisite to enhance program impact and sustainability (Shediac-Rizkallah & Bone, 1998; Stewart et al., 2009). In light of this, some intervention studies in African countries, conducted by involving various members of communities, documented positive results on nutrition of mothers and children (Aubel et al., 2001; Bezner Kerr et al., 2011; Bezner Kerr et al., 2008).

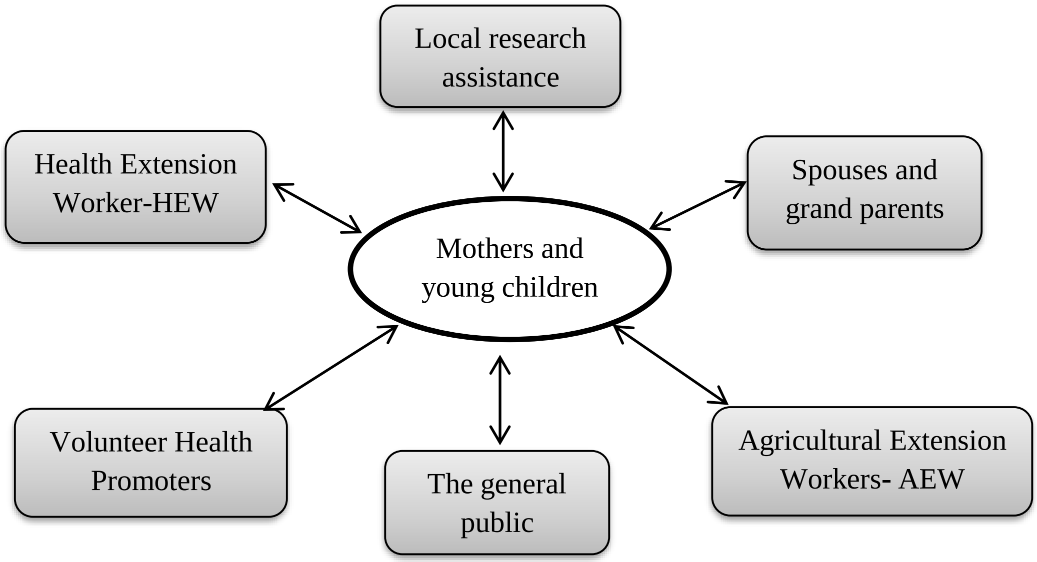


Figure A1 Illustration of how messages will be delivered and discussed from different direction

The approach of the current intervention study did take advantage of previous experiences to involve various community members beyond the specific targets. In order to enhance positive impact of the intervention, key nutrition messages were set-up to reach the target audiences from multiple directions, all from within the community. In addition, building community resources and capacity in terms of training local people as health promoters and nutrition educators would contribute to the likelihood of impact with elements of sustainability. The sketch (Figure A1) illustrates the model for delivering nutrition and nutrition related messages during the intervention.

The other strategy in this intervention was its reliance on existing resources and practices—i.e., the use of existing practices of pulse agriculture as entry point and AEW (Agricultural Extension Workers), HEW (Health Extension Workers) volunteer health promoters (Health Delivery Agents) and other community members. Economic benefits of pulse production, consumption of pulses and subsequent nutritional health benefit to mothers and children—ultimately, to the community—were used as key motivating factors for encouraging change in behaviour and practice in the target community.

Over all, principles from the Health Belief Model (HBM) were utilized in delivery of the nutrition education. The HBM theorises that people's readiness to take action (change in behaviour) is mainly influenced by their belief on perceived benefits of taking the new action which must out compete the barriers (see more details about the HBM in Section 2.10). The model is comprised of the following six main constructs:

- Perceived susceptibility and perceived severity
- Perceived benefits and perceived barriers
- Cues to action
- Self-efficacy (added more recently)

In the current intervention, even though all the principles embedded in the six constructs of the theory were utilized, emphasis was given in improving the perceived nutritional and other benefits of pulses to overcome potential barriers and encourage increased production and consumption among participants.

6. Intervention components

The intervention had the following two components:

A. Training of local Nutrition Educators - training and utilizing local nutrition educators and involving them in the conduct of the intervention would contribute toward building local capacity for implementing nutrition program at community levels.
B. Nutrition Education on promotion of pulses as part of health meals, other foods and related issues – this was the main component of the intervention. Outcomes were evaluated by employing different tools used to collect the baseline data.

7. Intervention Activities

- Training of local nutrition educators (included local Research Assistant (team leader/coordinator), agricultural and health extension workers, volunteer community health promoters also called community Health Delivery Agents);
- Monthly participatory discussion and learning by participants (facilitated by local NEr) and sharing of experiences and stories (inclusion of husbands was particularly to increase their intention to produce more pulses and also to create a support system for the women

to utilize more of the produce for household consumption than selling most of the produce at the market; similarly sharing of personal experiences and real life stories by participants were used as a key strategy for learning of nutrition issues by the target population);

- House to house visit by the Nutrition Educators (the two HEWs at each community alternate to do house-to-house visits as part of their routine activity: They could be trained to add some key messages on consumption of pulses for the mothers and children and the family at large. However, involvement of HEW was limited due their busy routine schedules in delivering other health extension packages)
- Counselling/education by the HEW at the health post each time a mother visits the post for routine health concerns
- Distribution of educational material to local nutrition educators so that they may use it to influence people in their neighbourhood and also during their house-to-house visits;
- Posting materials at or near the local health post, *Kebele* administrative office, near out-reach sites and agriculture offices where they can be easily viewed by members of the community

8. Length of the intervention and end line data gathering

The intervention was carried out for a period of six months but the education and promotion on consumption of pulses and healthy dietary practices may continue with the help of the HEW and other local volunteers and agricultural workers.

End-line data collection included the following major components:

- Dietary intake (from the same sub-sample as the base-line)
- Maternal and child anthropometry
- Frequency of consumption (specially of foods made from pulses)
- Dietary diversity scores
- Questionnaires (specially a section that assess their knowledge, attitude and practice with regard to pulse crops production, consumption)
- Interviews from local farmers

9. Poster content and design

The intervention included development of simple nutrition education material that was used to initiate education and learning on the importance of pulses (or foods made from pulses and cereals) as alternative sources of protein and some important micronutrients (such as iron and zinc). The poster also contained other key concepts such as food groups, balanced diet, diversifying diet, consumption of fruit and vegetables, tips on nutrition during critical periods (such as pregnancy, lactation and early childhood). These concepts were used to create or strengthen knowledge and practice with regard to pulse nutrition (poster is appended).

Background of the poster: Light blue or light green depending on the contrast with other pictures on the poster

Pictures: Various pictures on food groups and combinations of local food items with the theme of making complete proteins from plant based sources (complementary effect); food groups adopted to the local context

Nutrition messages:

- Understanding the concept of food groups and diversifying diet
- Importance of healthy eating before and during pregnancy and lactation for the health of both the mother and children
- Understanding the increased nutritional needs of mothers and growing children and hence prioritizing them during intra-household food distribution;
- Important contribution of pulses as good sources of protein and micronutrient, and how protein quality of pulses can be improved by combining them with other cereal crops;

  Notes: The basic principle in the combinations of most foods displayed on the picture is that combining pulses/legumes with cereals makes a complete protein and they can be alternative sources of protein with much lower cost than animal source foods. Besides the protein content, pulses can be significant sources of calories and micronutrients.

  Are animal foods necessary? The protein found in all animal foods is of high quality and is present in large amounts. If we are eating from varieties of plant based foods in adequate quantities, we do not need to eat animal source foods. Moreover, foods like peas, beans, lentils, chickpeas and nuts (pulses in general) also contain large amounts of protein, and therefore can promote growth as well. The protein in such foods is of a lower quality. When two or more protein-containing foods are mixed, the protein in the food mixture is improved to a better quality.

- Source of cash income through selling of pulses as they are high value crops compared to cereals and the money can be used to purchase other household essentials (such as buying fruits and vegetables for home consumption or pay cost of healthcare);
- Benefits of pulse agriculture in improving soil fertility, saving the money for other household needs which would otherwise be spent for purchase of artificial fertilizer;
- Sanitation, breastfeeding and complementary feeding practices;

  Note: Maintaining appropriate food safety and hygiene is mandatory for prevention of infectious diseases and food born or water born communicable diseases. Poor nutrition compromises the body's immunity increasing vulnerability to infection/communicable diseases which will lead to reduced appetite. Reduced intake of food due to sickness may further leads to poor nutrition or nutritional which will again compromise the body's defence against infection and the cycle continues.

10. Nutrition Message contents and outline for the monthly sessions and home visits

(Note: Following the baseline study, a separate booklet was prepared for educators to use as a guide during the intervention. Please see Appendix B)

Session	Topics	Content highlights	Duration
1	Tips on nutrition during pregnancy, lactation early childhood.	• Importance of healthy eating before and during pregnancy and lactation for the health of both the mother and children; • Understanding the increased nutritional needs of mothers and growing children and hence prioritizing them during intra-household food distribution;	45 min-1 hr
2	Food groups & diversifying diets	• Understanding the concept of food groups and diversifying diet	45 min-1 hr
3	Improving protein quality of cereal-based foods with pulses	• Important contribution of pulses as good sources of protein and micronutrient, and • how protein quality of cereals can be improved by combining them with pulses crops;	45 min-1 hr
4	Consumption of fruits & vegetables	• Understanding the importance of including fruits and vegetables in the diet	45 min-1 hr

5	Benefits of pulses	• Benefits of pulse agriculture in improving soil fertility, saving the money for other household needs which would otherwise be spent for purchase of artificial fertilizer; • Source of cash income through selling of pulses as they are high value crops;	45 min-1 hr
6	Sanitation/hygiene	• Basics of personal and environmental hygiene, • Hygiene during child feeding (breastfeeding and complementary feeding) practices;	45 min-1 hr9

11. Intervention Logic Model

Figure A2 on the next page summarizes the intervention segment of the project by using program logic model. A logic model is graphic summary displaying logical linkages between program resources (inputs), program activities and participation (outputs) to desired short term and long term results (outcomes) (McCawley, 2001; W.K. Kellogg Foundation, 2004a). It is a program theory pictorially representing how program resources, processes and activities, under certain assumptions, would lead to expected outcomes in the target group (W.K. Kellogg Foundation, 2004a).

A program logic model may come in different size and complexity depending on the size of the program and purpose of the model (W.K. Kellogg Foundation, 2004b) but basic logic model shows the connection between program inputs, outputs and outcome. Inputs may refer to resources being put into the program and may include staff, organizational and community resource, finance, time and other similar resources. Whereas, outputs may refer to the program activities/processes and participation that come as part of the program implementation to bring about the desired outcome (W.K. Kellogg Foundation, 2004b). Outcomes can be short or long term and refers to behavioural changes or increased knowledge among the target as a result of participation in the program.

In this research, the program logic model is intended to represent the planning of a community based nutrition education intervention on promotion of pulse crops production and consumption in pulse growing rural communities of Ethiopia. The model included the following components:

A. Situations: refer to the condition or characteristics of the community before the start of the intervention. Examples include: limited knowledge on the important role of pulses, negative attitudes towards foods made from pulses, production that is below normal.
B. Inputs: refers to resources to carry out the different aspects or components of the intervention and may include training material, facilitator notes, posters, local nutrition educators, community facility to conduct the training and the actual nutrition education and similar resources.
C. Outputs: refers to the intervention activities and participation including the training of local nutrition educators and the delivery of the nutrition education to the target audience (mothers, husbands, the community as a whole) as outlined for the period of six months.
D. Outcomes: the expected short term outcomes included number of trained local nutrition educators, improved knowledge on important roles of pulse corps for nutrition as well as improving soil quality, improvement in the short term nutritional status of mothers and children. Intermediate and long term outcomes may include increased production and consumption of pulse and foods made from pulses which, along other related practices, will improve nutrition situation of the community.
E. Assumption: conditions necessary for the logic model to work. There can be several assumptions involved in the carrying out of this intervention. One example can be that at least one pulse crop should be grown and/or consumed in the target communities.
F. External factors: Factors that may affect the outcome or interfere with the conduct of the intervention. Seasonal food insecurity or activities of other programs can be some examples.
G. Evaluation: refers to how the outcome of the nutrition education intervention is going to be assessed. Data from baseline shall be recollected to measure outcomes of intervention.

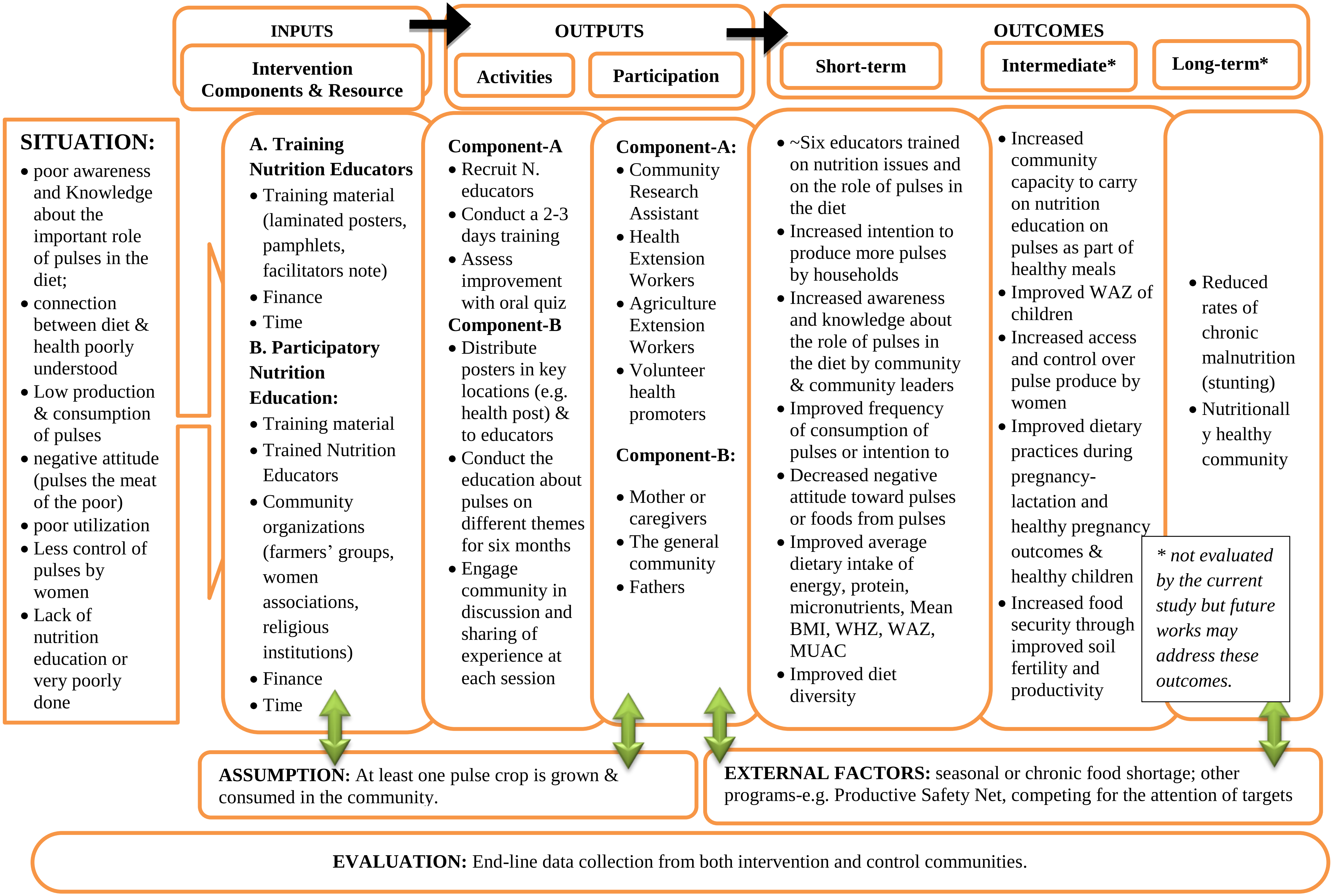


Figure A2. Community-based Promotion of Pulses as Part of Healthy Meals in Rural Communities: Program Logic Model

Appendix B: Guide for nutrition educators

Community-Based Nutrition Education Intervention on Promoting Pulses as Part of Healthy Meals in Pulse Growing Communities: the case of *Halaba* Special Woreda, south Ethiopia

~Guide for educators

By:

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University of Saskatchewan

Holagoba-Kukie Community,

Halaba Special Woreda/District

July 2013

Mothers from Holagoba Kukie Kebele (intervention community), waiting outside of the local health post for anthropometric measurements for them and their young children

Guide for facilitators (Nutrition Educators) while using the *Pulse and Healthy Eating* poster during community meetings and home visits

Introduction

This small booklet contains an outline and content of a nutrition education intervention to be conducted at a community[18] level by local Nutrition Educators[19]. The educational intervention is intended for a period of six months following a baseline base-line study that showed nutrition concerns among mothers and young children in rural communities of *Halaba Special Woreda*, south Ethiopia. The intervention is to be conducted in one of the two leading pulse growing communities (*Holagoba-Kukie*) of *Halaba*. It comprises six sessions, one topic per month to be delivered at a monthly community meeting (see section A for topics, *next page*). In addition, participants will receive one or two home-visits per month for individual learning (i.e., minimum of six to maximum of 12 visits during the six-month intervention period).

Each session's lesson is intended to focus on a single nutrition or nutrition related issue with one key nutrition message. The ***Pulse and Healthy Eating*** poster (see Appendix C) prepared for this intervention should be used with each session's lesson. Overall, the education intervention has, as its core theme, the promotion of pulse production and consumption in the intervention community. Therefore, educators are encouraged to emphasis this theme throughout the period of the intervention. Up on completion, a follow up study will be conducted to assess impact of the intervention.

[18] In this booklet, a community is the same as *Kebele* (the smallest administrative unit in Ethiopian government structure).
[19] Nutrition Educators refers to individuals (local people) trained to conduct this intervention and includes local agriculture and health extension workers.

A. Outline of nutrition topics & content highlights for monthly sessions and home visits

Session	Topics	Content highlights	Duration
1	Tips on nutrition during pregnancy, lactation early childhood.	• Importance of healthy eating before and during pregnancy and lactation for the health of both the mother and children; • Understanding the increased nutritional needs of mothers and growing children and hence prioritizing them during intra-household food distribution;	45 min-1 hr
2	Food groups & diversifying diets	• Understanding the concept of food groups and diversifying diet	45 min-1 hr
3	Improving protein quality of cereal-based foods with pulses	• Important contribution of pulses as good sources of protein and micronutrient, and • how protein quality of cereals can be improved by combining them with pulses crops;	45 min-1 hr
4	Consumption of fruits & vegetables	• Understanding the importance of including fruits and vegetables in the diet	45 min-1 hr
5	Benefits of pulses	• Benefits of pulse agriculture in improving soil fertility, saving the money for other household needs which would otherwise be spent for purchase of artificial fertilizer; • Source of cash income through selling of pulses as they are high value crops;	45 min-1 hr
6	Sanitation/hygiene	• Basics of personal and environmental hygiene, • Hygiene during child feeding (breastfeeding and complementary feeding) practices;	45 min-1 hr

B: Lessons for each monthly sessions and home-visits

General guideline for the Nutrition Educators:

- The nutrition and nutrition related topics for the six-month period (one topic per month) are organized in six separate pages starting from the next page
- All topics contain the following sub-topics
    - *Introduction:* provides brief introduction on the topic of the month
    - *Activities/interactive learning:* contains ideas and questions which the educators can use to initiate learning through discussion among participants.
    - *Notes:* provides some examples of facts related the topic of the day which educators can use to enrich the discussion and the learning experience
    - *Key-message:* provides one key message related to the topic for the day and educators are encouraged to ensure that participants grasp this as a 'take-home' message.
    - *In closing:* some closing remarks and cues for action which educators may leave with participants as they close the discussion.
- Use the '*Pulses and Healthy Meal*s' poster to deliver a brief introduction on the session's lesson and then encourage learning through discussion.
- Use the questions provided under 'Activities/interactive learning' section to help you initiate discussion.
- At each session, encourage participants to briefly share personal stories/experiences, of their own or of someone they know, regarding mother-child nutrition and health issues that others can learn from.
- Educators should remember that their role is not to give a 'lecture' on the topic but to facilitate the learning experience of participants by allowing them discuss and learn from each other's experience and stories.
- At the beginning of a new session, remember to revise previous topics by asking participants what practical steps they might have taken based on previous lesson (use the ideas in the 'In closing' section to help you with the revision).

Session 1: Tips on nutrition during pregnancy, lactation and early childhood.

Introduction:
People at all stages of life need the same nutrients. But the amount of nutrient their body needs differs based on stages of life and physiological status. The nutritional requirement of pregnant and lactating women as well as young children is an area needing special attention. In many developing countries, mothers and small children are considered nutritionally vulnerable segment of the general population. Hence special attention should be given to them in order to address their nutrition needs.

Activities/interactive learning:
Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- In your culture and community, who gets to eat first and who gets to eat last? Why?
- Who do you think should get the most nutritious food in the family? Why?
- What happens if a pregnant or a lactating mom does not eat well? What can you do to change that?
- How much should a pregnant mother eat? Who should eat more food, a pregnant or a lactating mother? Why? Discuss.
- How long after birth should a child start breastfeeding? How often should you breast feed within a day? For how many months should a child be fed breast milk only? Why?
- When should you start giving other food to your child? What are the common complementary foods you give to small children in your community? Is it adequate? If not, what can you do to improve it?

Note:

- A pregnant mother should gain adequate weight (11-16kg) during gestation for her to stay healthy and avoid low birth weight baby (< 2.5kg), a risk factor for child survival.
- She also needs to increase her dietary intake to support both her health and the growth and development of the foetus in her womb.
- A lactating mother needs to increase her dietary intake even more to support the growth of the infant during the periods of exclusive breastfeeding (EBF) and complementary feeding.
- EBF should be practiced for the first six months of life and should be continued at least up to 24 months of age with safe and adequate complementary foods.
- Introduce complementary foods at six months of age; do not delay or start too early.

<u>Key message/s:</u> Prioritise the nutrition of pregnant & lactating mothers and also children. Mothers and children should be given priority in the intra household food distribution.

In closing: Ask what participants can do to ensure the nutritional needs of mothers’ and children’ remain a priority in their community?

Session 2: Food groups and diversifying diets

Introduction:

There are different groups of foods. Each group of food is good source of one or more nutrient. For example, fruits and vegetables are good sources of vitamins and minerals; whereas pulses are good sources of plant based proteins which complement cereals. Therefore, a healthy meal is one that contains variety of foods from different food groups.

Activities/interactive learning:

Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- Which of these foods do you locally grow or are readily available?
- Which of the food groups are most expensive? What can you do to replace them or what do you think should be done?
- Why do we have to know about food groups? Is knowledge of food groups important? Why?
- Which foods should we eat every day and which not?
- Which food items should we take in large amount and which in small amount? Why?

<u>Note:</u>

- Understanding the concept of food groups is crucial in order to be able to prepare healthy meals/balanced diet.
- It is difficult to prepare a balanced diet for ourselves or children if we don't know what to balance.
- Therefore, balancing our diet requires basic understanding of food groups.

<u>Key message/s:</u>

- ❖ **A healthy meal/diet is one that includes variety of foods from the different food groups.**

In closing: Ask participants what kind of healthy meals they can prepare from locally available foods.

Session 3: Improving protein qualities of cereals with pulses (Complementary effect)

Introduction:

Growing children and also adults need protein for building and maintenance and reparire of their body. Animal source foods are good source of quality protein (complete protein) but they are mostly expensive for most families to include them in their regular diet. Foods from pulses and cereals can be best alternative sources for meeting protein needs and are relatively cheap.

Activities/interactive learning:

Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- Do you think we can make complete protein by combining only plant source foods and without including any animal source food? If yes, how? Or if no, why not?
- How can we make alternative and reliable protein source by combining food groups?
- What do you rely on to meet the protein needs for your families?
- Are the food combinations you see on the poster familiar to you?
- What other food combinations of locally available foods can you come up? Do you think the foods you mentioned have complete protein?

Note:

- the basic principle in the combinations of most foods displayed is that combining pulses/legumes with cereals makes a complete protein;
- Pulses, combined with cereals, can be alternative sources of protein with much lower cost than animal source foods.
- Besides the protein, they can be good sources of healthy calories and micronutrients (e.g. iron &Zinc)

Key message/s:

❖ **Combining foods from cereals with pulses (e.g. kidney beans) makes a good quality protein (complete protein)**

In closing: Ask participants (mothers) what kind of foods they make from beans and cereals. Encourage them to feed their children by combining foods based on today’s lesson.

Session 4: Consumption of fruits and vegetables

Introduction:

Fruits and vegetables should be very important part of our daily diet. They provide a number of vitamins and minerals as well as dietary fibers which are all necessary for healthy function of our body. We can increase our body's immunity (defence against disease and sickness) by consuming fruits and vegetables daily.

Activities/interactive learning:

Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- Can you give examples of fruits? Which of these are found/ common in your area?
- Can you give examples of vegetables? Which of these are produced/accessed in your area?
- What are the barriers in your community that makes it difficult for you to consume fruits and vegetables?
- What can you do to improve your consumption of fruits and vegetable?

Note:

- Examples of common fruits: Avocado, orange, mango, banana, lemon, pineapple, papaya, guava, grape, watermelon, pumpkin
- Examples of vegetables: carrots, kale, cabbage, lettuce, spinach, beetroot, tomato, onion,
- Dietary fiber is beneficial for maintaining bowel health and lowering cholesterol.
- Orange fruits and vegetables (e.g. carrot, pumpkin, orange flesh sweet potato, papaya) are good source of beta-carotene, a compound our body uses to make vitamin A. Vitamin A is good for our vision and also immunity.
- Red and pink fruits and vegetables (guava, tomatoes) tend to have high levels of vitamin c. Broccoli is also good source of vitamin c which are all good for the body's defence.

<u>Key message/s:</u>

❖ **Fruits and vegetables are excellent sources of nutrients that help our body to fight off disease/sickness.**

In closing: Ask participants (mothers) how they would go about improving their fruit and vegetable intake (both for themselves and their children)

Session 5: Benefits of pulses/pulse production

Introduction:

Pulse crops include different types of beans (haricot bean, kidney bean), faba-bean, chick pea, lentil, peas and others. Production of pulses has benefits that go beyond just good nutrition. Pulses have nutritional, health and environmental advantages. Understanding the benefits of pulses is what forms the bases for promotion of pulse production and consumption in your community.

Activities/interactive learning:

Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- What benefits of pulse production can you mention, other than their use as food item in the household? (Encourage participants to mention as many benefits of pulses as they can).
- For what purpose do you mainly grow pulse crops? (Hint: for home consumption as food, for market).

Note:

- Pulses are good sources protein, dietary fiber & other micronutrients (zinc, iron, folate).
- Their protein quality is enhanced when used along with cereals (the missing essential amino acid in cereal is found in pulses and vice versa; therefore, these food groups when used together, complement each other to make a complete or good quality protein.)
- Pulse foods are of low glycemic index (i.e. they release their sugar slowly into the blood during digestion); hence they are beneficial to control blood glucose levels (particular significance to people with diabetes).
- Pulses are high value crops so they can be cash-crops for farming households and hence support the household cash income
- As legumes, they are nitrogen fixers; hence they improve the soil fertility by adding nitrogen into the soil they are grown. They require low farm inputs (fertilizer, moisture)
- They also minimize fertilizer expenses since they naturally improve the soil nitrogen
- They complement cereals; also play important role in household food security;

Key message/s:

- ❖ **Pulses are nutritious, good for health and contribute to healthy environment by making their won natural fertilizer.**

In closing: Encourage participants to appreciate the numerous benefits of pulses. Ask them if they would consider improving their production and consumption of pulses at the household level.

Session 6: Other important issues: Sanitation

Introduction:

Good nutrition alone is not sufficient for healthy living. Maintaining proper personal and environmental hygiene is also crucial for our health. Liquid and solid wastes should be disposed properly away from the living environment. Hand-washing before food preparation, child feeding (including breastfeeding) and after toilet are recommended practices to prevent communicable/infectious diseases (e.g. diarrhoea in small children).

Activities/interactive learning:
Use the poster and ask any of the following questions to initiate discussion. Encourage mother (participants) to share their knowledge and experience.

- Is nutrition and hygiene related? How does poor hygiene affect our nutritional health?
- What are some of the sanitary measures you practice at your household level and in your neighbourhood? *(**<u>During home-to-home visits</u>**: please observe the sanitary practices of the mother/caregivers at various occasions such as during food preparation or child feeding; observe also how the house is kept and the ways liquid and solid wastes are disposed. After your observation, discuss with the mother and members the household on ways to improve sanitation around the home).*
- Where do you get your drinking water? What kind of water do you use for food preparation? Is it safe? Discuss.
- If the drinking water in your community is not safe, what way can you use to improve the safety?

Note:

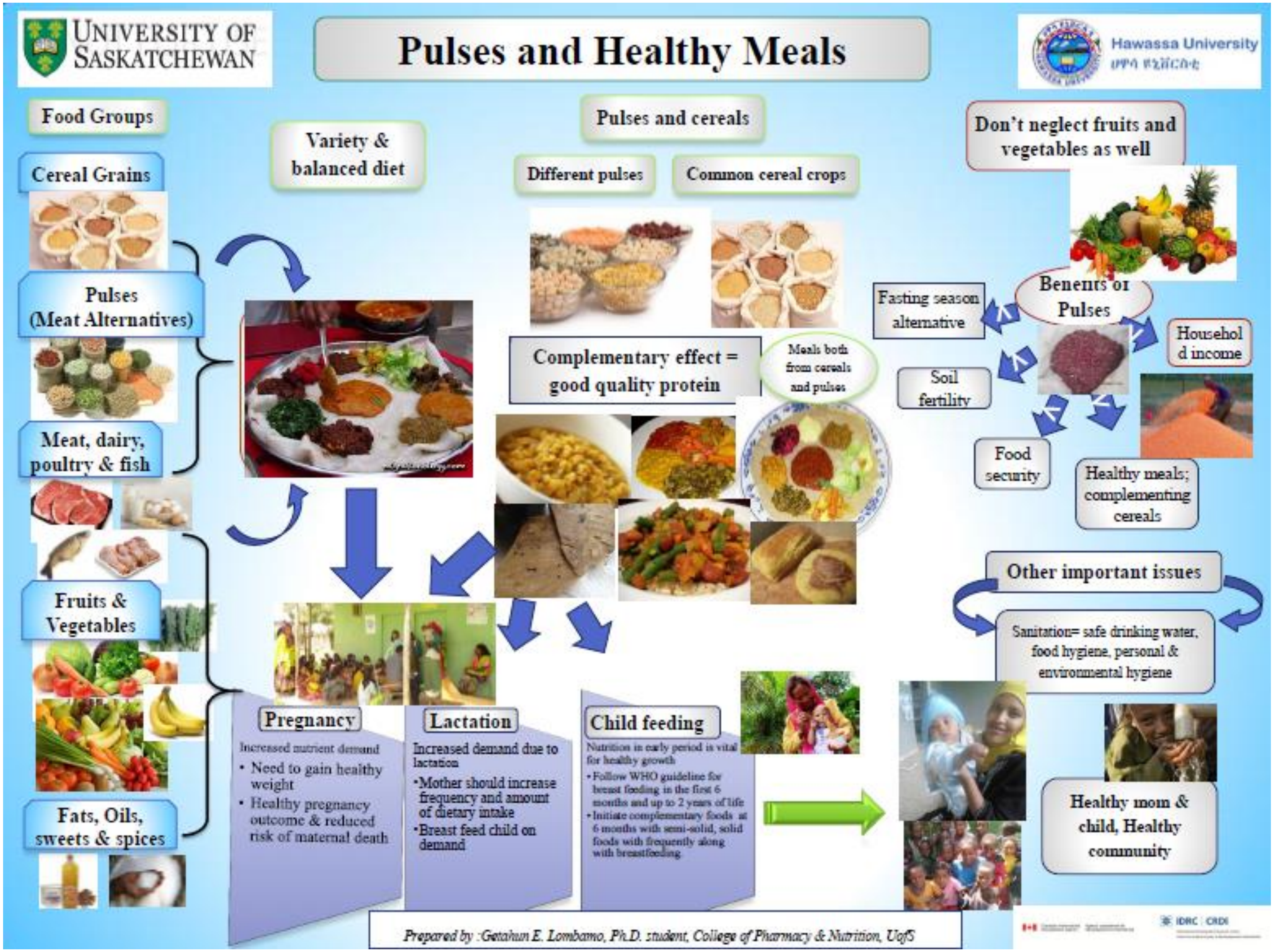
- Poor hygiene may predispose children to infectious disease which will affect their food intake due to loss of appetite. This further leads to poor nutritional status and compromised immunity resulting in poor health and/or even death if proper medical help is not sought.
- Clean water is one of the six nutrients our body needs for healthy functioning.

<u>Key message/s:</u>

- ❖ Maintain a healthy environment for children by keeping your homestead clean and handling food hygienically, practicing hand washing as often as possible.

In closing: emphasize the importance of food hygiene, personal and environmental sanitation as well as use of clean water for drinking. Ask participants what practical steps they would take based on today's discussion (e.g. keep dirty flies away from the face of small children by keeping them clean).

Appendix C: Sample poster: Pulses and healthy meals



Appendix D: Results based on application of the Health Belief Model to understand the behaviour of mothers in pulse or cereal-growing rural communities in Ethiopia

Abstract

Nutrition and health related behaviour is influenced by one's perception of susceptibility to and magnitude of health risks as well as perceived benefits of proposed behaviour. Pulses (low fat legumes) are excellent sources of protein and micronutrients; thus, increased consumption would benefit those at risk for undernutrition. In a comparative study in pulse or cereal-growing rural communities of Ethiopia**,** the Health Belief Model (HBM) was applied to understand the nutrition related health beliefs of mothers. Mothers (n=620) from two pulse growing (Halaba) and one cereal growing (Zeway) rural communities in Ethiopia were selected randomly from households with children <5 years of age. In addition to participant characteristics, the questionnaire included 18 items, three for each of the six HBM domains (i.e., perceived susceptibility and severity, perceived benefits and barriers, cues for action and self-efficacy). Using a 5-point hedonic scale (1=strongly disagree to 5=strongly agree), respondents were asked to what extent they agree to each of the items. Scores for 'perceived severity of consequences of poor dietary practices' were 3.29±0.89 in pulse and 3.51±0.76 in cereal communities, respectively ($p < 0.01$). For 'perceived barriers to pulse consumption', scores were 2.71±0.93 in pulse and 2.34±0.86 in cereal communities, respectively ($p < 0.01$). Scores on perceived 'cues to action' (enabling factors) were significantly higher ($p < 0.01$) in pulse (3.62±0.84) than cereal (3.19±0.77) communities. No significant differences were observed for other domains. The findings suggest that mothers in pulse-communities perceived lower severity of risk of poor dietary practices, greater barriers to pulse consumption but also were aware of more enabling factors than mothers in the cereal growing community. The pulse growing communities may benefit from a nutrition intervention that raises awareness on the health consequences of poor dietary practices, and utilizes enabling factors to promote the benefits and tackle the barriers in pulse consumption.

Key words: *Health Belief Model, nutrition, pulses, rural Ethiopia*

Results

The following sections present findings based on questions framed under six constructs of the Health Belief Model (HBM) and that were administered for mothers in pulse and cereal growing communities of *Halaba* and *Zeway*, respectively. The six constructs that framed the interview questions include *perceived susceptibility* and *severity*; *perceived benefit* and *barriers*; *perceived cues for action* and *self-efficacy*. The mothers' perceptions of benefits and barriers to consumption of pulses, and other foods that may have improved their nutrition, were assessed using three questions under each of the six constructs. The responses of participants were captured in 5-points Likert Scale (1= strongly disagree to 5=strongly agree). The median score, with 25th and 75th percentile values, were presented for each of the three item under each of the six domains. In addition, the average scores of the three items for each of the six domains were calculated and presented separately. An average/median score closer to 5 indicates a desired outcome and represents participant's agreement to the proposed claim (e.g. pulses are good sources of protein, i.e., perceived benefits of consumption of pulses) and vice versa.

Maternal perceived susceptibility to and severity of consequences of poor dietary practices

Table D1 presents scores on perceived *susceptibility* (to malnutrition of the mother or their child due to not eating well) and *severity* of possible consequences of poor dietary practices. Out of the three items intended to measure maternal perception of susceptibility, pulse-growing mothers had significantly higher score for one i.e., not changing/improving current diet will lead to malnourishment ($p < 0.05$). perception of susceptibility to malnutrition based on the other two items under this domain did not differ between communities.

Similarly, median score on one of the three items measuring maternal perception of *severity* of malnutrition due to not eating well was significantly lower for the pulse mothers than the those from the cereal community ($p < 0.001$). Which means pulse mothers were less worried about the seriousness of child malnourishment at her stages. Median scores on other items under the severity domain did not differ significantly between pulse vs. cereal mothers.

Maternal perception of the benefits of pulses and barriers to the consumption of pulses

Perceptions of benefits of pulses and barriers to the consumption of pulse as part of health meals are summarized in Table D2. Accordingly, the results indicated that the pulse mothers had significantly lower score on one of the three items on perceived benefits of pulses ($p < 0.01$). That is mothers had less confidence that pulses, eaten along with other food groups, would be sufficient source of protein even in the absence of consumption from animal source foods such as meat. Again score on the other perceived benefit items did not differ significantly between communities.

Table D1. Median (25th, 75th) responses, based on a 5-point hedonic scale, to maternal perceived susceptibility to and severity of consequence of poor dietary practices in pulse versus cereal-growing rural communities in Halaba and Zeway area, respectively, Ethiopia, 2013 (*n=~620)*

	Pulse growing	Cereal growing
Items under 'Perceived Susceptibility' of HBM domain	n=410	n=213
'If I eat *less than usual* during pregnancy and lactation, I may become malnourished.'	4 (3, 5)	4 (4, 4)
'If my child and I continue without changing what we are currently eating, both of us may become malnourished sooner or later.' [a]	4 (3, 5) [*]	4 (3, 4)
'Not having to eating more than usual during pregnancy will help me have smaller (light-weight) baby at birth and hence, not eating *more than usual* during pregnancy is a good practice.' [b]	3 (2, 4)	3 (2, 4)
Items under the HBM domain of 'Perceived Severity (to consequences of poor dietary practices'	n=408	n=212
'I am scared of giving birth to a small sized baby because I fail to eat well during pregnancy.'	3 (3, 4)	3 (2, 4)
'Not eating from varieties (including pulses) during pregnancy and lactation may severely affect both my health and my child's health.'	4 (3, 4)	4 (3, 4)
'If my child is malnourished at early age (0-5 years), it doesn't bother me a lot because s/he will be well when grown-up.' [b]	3 (2, 4) [***]	4 (2, 5)

[a] The assumption for this item is that diets in most parts of rural Ethiopia are suboptimal as evidenced in the national Demographic and Health Surveys from 2000, 2005, 2010 and other studies; [b] results for these items have been reverse-scored so interpretation would be consistent with other items in the scale; [*]difference significant at $p < 0.05$ and [***]significant at $p < 0.001$ (*Mann Whitney U test*); HBM = Health Belief Model; Scale: 1= strongly disagree to 5= strongly agree; the higher the score the better;

However, scores on *perceived barriers* to consumption of pulses were higher for all three items under this domain for pulse than cereal mothers and difference were very significant ($p < 0.01$ or < 0.001). That is in comparison to cereal mothers, mothers in the pulse communities did not believe pulses were that much of a benefit to their nutrition as well as that of their children's; they thought pulses were boring and poor people's food, and they also thought pulse were not cheap but time taking to cook and not good for their belly as they may cause gas (flatulence).

Table D2. Median (25th, 75th) responses, based on a 5-point hedonic scale, to perceived nutritional and other benefit of pulses as well as perceived barriers to consumption of pulses by mothers from pulse and cereal growing rural communities in Halaba and Zeway areas, respectively, Ethiopia, 2013

	Pulse growing	Cereal growing
Items under the HBM domain of 'Perceived Benefits' (of pulses)	n=411	n=212
'If my child and I regularly eat pulses along with cereals and other foods, our nutritional health will be good even if we are not eating meat and meat products'	3 (2, 4) **	4 (3, 4)
'I believe pulse (like beans, lentil, chickpea, peas…) are good sources of protein and other important micronutrients beneficial to my and my child's nutritional health.'	4 (3, 5)	4 (3, 4)
'Pulses are good not only for my and my child's nutrition but also for increasing the productivity of our farm, increase our household income and food security.'	4 (3, 5)	4 (3, 4)
Items under the HBM domain of 'Perceived Barriers' (to consumption of pulses)	n=406	n=210
'I don't believe eating pulses is that much beneficial for my child's nutritional health or mine.'	3 (2, 4) ***	2 (2, 3)
Eating pulses often is boring and pulses are foods for poor people only (e.g. people who cannot afford animal source foods)'	3 (1, 4) **	2 (2, 3)
'Pulses are not cheap and preparing them is time consuming and they are not good for belly (e.g. flatulence) so I don't think I will eat more pulses in the future.'	3 (2, 4) ***	2 (2, 3)

** difference significant at $p < 0.01$ and *** significant at $p < 0.001$ (Mann Whitney U test); HBM = Health Belief Model; (Scale: 1= strongly disagree to 5= strongly agree; the higher the score the better)

Cues to action (i.e., consumption of pulses) and self-efficacy of mothers to adapt healthier diet related behaviours

Responses to items under 'cues to action' and 'self-efficacy' domains are summarized in Table D3. Pulse mothers generally had higher scores on all the three items under 'cues to action' domain and differences between pulse versus cereal communities were significant in two of these three items. The cues to action identified by the three items were pulse production for home or market in the community; intentions to produce/purchase more pulses for home consumption, access to nutrition education on the role of pulses in their diet.

Table D1. Responses scores [Median (25th, 75th)] of mothers in pulse or cereal growing communities in Halaba and Zeway, respectively, based on 5-point hedonic scale, to perceived cures to action (consumption of pulses) and perceived self-efficacy to adapt healthier dietary behaviours, Ethiopia 2013

	Pulse growing	Cereal growing
Items under the HBM domain of 'Cues to action' (consumption of pulses)	n=402	n=207
'We produce pulses for household consumption and for market.'	4 (4, 5) ***	3 (2, 4)
'Even if we don't grow a lot of pulse crops, we will plan to produce/purchase more in the future for household consumption.'	4 (3, 5)	4 (3, 4)
'I usually get nutrition education on the important roles of pulses in my diet from local nutrition educators.'	3 (2, 4) ***	2 (2, 4)
Items under the HBM domain of 'Self-efficacy'	n=399	n= 209
'If different food items are available at home, I know how to prepare balanced diet by including variety of foods in a meal.'	4 (3, 4)	4 (3, 4)
'I know how to prepare different dishes from pulses by combining them with other foods to increase their protein quality.'	3 (2, 4)	4 (2, 4)
'I have a better understanding of how I should eat during pregnancy and lactation for the benefit of both my child's health and of myself.'	3 (2, 4)	4 (2, 4)

***difference significant at $p < 0.001$ (Mann Whitney U test); HBM= Health Belief Model; (Scale: 1=strongly disagree to 5= strongly agree; the higher the score the better);

However, scores on all the three of self-efficacy items did not differ between mothers from pulse versus cereal growing communities. Median scores for two of the three 'self-efficacy' items appeared to be lower for pulse than cereal mothers but not significantly enough (Table D3).

Average scores on the six domains of the HBM for mothers from pulse or cereal growing rural communities in Ethiopia

Table D4 average scores of each of the three items under each of the six HBM constructs. The results showed that the mean score for *perceived susceptibility to consequences of poor dietary practices* were 3.56 and 3.52 in pulse and cereal groups, respectively. Mothers in pulse communities tended to agree more to their vulnerability to consequences of poor dietary practices than mothers from the cereal community; however, the difference was not statistically significant.

Even though mothers from both groups tended to give affirmative responses to items under *perceived severity of consequences of poor nutritional practices*, the average score for the pulse community (3.29) was significantly lower ($p < 0.01$) than the average score for the cereal group mothers (3.51). The observed lower perception for severity of consequences poor

Table D4. Summary scores (mean ± SD) to the six main domains of the HBM based on a 5-point hedonic scale for mothers in pulse or cereal growing rural communities in Halaba and Zeway area, respectively, Ethiopia, 2013 (Scale: 1= strongly disagree to 5=strongly agree)

	Pulse growing	Cereal growing
Main items of the HBM domain		
Perceived susceptibility to consequences of poor dietary practices *(n_p=410, n_c=213)*	3.56 ± 0.91	3.52 ± 0.84
Perceived severity of consequences of poor dietary practices *(n_p=408, n_c=212)*	3.29 ± 0.84**	3.51 ±0.76
Perceived benefits of pulses *(n_p=411, n_c=212)*	3.52 ± 0.74	3.63 ± 0.67
Perceived barriers to consumption of pulses *(n_p=406, n_c=210)*	2.71± 0.93**	2.34 ± 0.86
Cues to action (consumption of pulses) *(n_p=410, n_c=207)*	3.62 ±0.84**	3.19 ± 0.77
Self-efficacy (of mothers to take healthy steps in dietary practices) *(n_p=399, n_c=209)*	3.25 ± 0.87	3.31 ± 0.85

**significantly different from estimates for pulse group at $p < 0.01$ (independent. t-test and *Mann Whitney U* test); n_p= sample size in the pulse growing community; n_c =sample size for cereal growing community;

nutritional practices in the pulse group may affect participants' motivation to adopt improved nutritional practices (i.e., if participants are not threatened by the severity of consequences of poor nutritional practices, they will be less inclined to pick up new practices that might be recommended as better alternatives).

No significant difference was found between groups on responses related to the *perceived benefits of pulse* production and consumption. Mothers from both groups tended to agree to the perceived benefits of pulses with average scores of 3.52 and 3.63 in pulse and cereal communities, respectively. However, the average scores also indicated a lower perception (3.52) for possible benefits of pulses among mothers from pulse communities indicating the existence loophole for potentials to increase production and consumption of pulse in these communities by elaborating the benefits of pulses through community-based nutrition education programs.

Compared to the cereal group (2.34), perceived barriers to consumption of pulses or foods made from pulses were more pronounced in the pulse growing communities (2.71) and the difference was significant at $p < 0.01$. This was a further evidence that there was a need to strengthen the education on possible benefits of production and consumption of pulses so that the perception to possible barriers could be overcome.

The Average scores (3.62 in pulse and 3.19 in cereal) under the domain of cues for action (i.e., consumption of pulses) indicated that mothers from pulse-growing communities were more likely ($p < 0.01$) to agree to the presence of supportive environment for consumption of pulses compared to mothers from cereal-growing community. However, they did not show any stronger confidence (self-efficacy) to carry out the desired action as there was no statistical difference between the groups in the average scores (3.25 in pulse and 3.31 in cereal) for self-efficacy domain.

These results further supported the need to boost the knowledge/awareness base of the pulse-growing communities with regard to benefits of pulse production and consumption as well as about the need to diversify their diet so that they may, in the process, gain increased self-efficacy for taking actions in the desired direction.

Appendix E: Data collection tools- questionnaire and forms:

Participant's code: ____

University of Saskatchewan
College of Pharmacy and Nutrition
Questionnaire for assessing dietary habits, food security, nutritional & health status

Name of administrative unit/ Kebele: ____________ Region: _____________
Zone: _______________ District: ______________
Date of interview: _____/____/_______ Interviewers name: ________________
Supervisor's name_____________ Date__________ signature_______________

Part I: Demographic and socio-economic characteristics participants

No	Questions	Response options (coded)	Skip
101	How old are you?	_________________ Years. (If estimated, please explain how) ______________ ______________________________ _____	
102	Household Composition Number of**:**	Male children =________ Female children=_______ Mother and Father= _______ Other people staying in the household=_______ Total household size= _______	
103	How many children do you have who are less than 5 years of age?	_______________	
104	What is the religion of your household members?	1. Orthodox 2. Muslim 3. Protestant 4. Catholic 5. Other ___________________	
105	What is your current marital status?	1. Married 2. Divorced 3. Widowed 4. Separated 5. Other __________________	
106	Does your husband have another wife?	0. No 1. Yes	→108
107	If yes, what order are you?	1. First wife 2. Second wife 3. Third wife 4. Other specify ______________ __________________________	

108	Can you read and/or write/ Have you had any formal education?	0. No 1. Yes	→110
109	What is the highest level of schooling you have achieved?	____________________	
110	Has your husband had any formal education?	0. No 1. Yes	→112
111	What is the highest level of schooling your husband achieved?	_______________________	
112	Who is the head of the household?	1. Yourself 2. Husband 3. Grandparent 4. Other, specify ______________	
113	Does your household own cultivated land?	0. No 1. Yes	→115
114	What is the size of your land? Note: 1 "*Timad*"= ¼ ha	______ ha ______ "*Timad*"	
115	Do you have *Enset* plants?	0. No 1. Yes	→117
116	How many mature Enset plants do you grow? (Use zero for none)	_________________	
117	What is your usual occupation?	1. House wife 2. Civil Servant 3. Farmer 4. Petty Trader 5. Other, specify ____________	
118	What is the main occupation of your husband?	1. Unemployed 2. Farmer 3. Tenant Farmer 4. Civil Servant 5. Agricultural Labor 6. Daily Labor) 7. Self- Employed 8. Paid Employment 9. Non–farming 10. Other _____________	
119	What is the average monthly income of your household? *(If possible, ask for exact amount: ________)*	1. <500 Et birr 2. 500-100 Et birr 3. 1001-1500 Et birr 4. > 1500 Et birr 5. Other, specify________________	
120	Does your household own any animals? <u>Animals</u> Ox Cow	 No Yes Number 0 1 ________ 0 1 ________	

	Goat Sheep Donkey Horse/mule Other	0 1 ________ 0 1 ________ 0 1 ________ 0 1 ________ 0 1 ________	
121	Do you have any of the following things in your house that are functioning?	1. Radio/ tape player 2. Television 3. Bicycle 4. Hand torch 5. Mobile phone 6. Horse/donkey cart 7. Other ________________ 8. None of these	
122	What type of house do you live in?	1. Thatched Grass roof 2. Corrugated iron roof & wood & mud walls 3. Walls covered with cement and Corrugated iron roof 4. Other ________________	
123	How many rooms does your main house have?	________________Rooms	
124	Where do domestic animals spend the night?	0. No domestic animals 1. Same house, same section 2. Same house, separate section 3. Separate place 4. Other (specify) ___________________	
125	What are the windows of your house made of?	0. The house does not have windows 1. Open windows 2. Screening 3. Wood shutters 4. Other___________________	
126	What is the floor material of your house?	1. Mud /Earth 2. Cow dung smeared 3. Cement 4. Other ________________	
127	What kind of toilet facility does your household use?	0. No toilet 1. Traditional pit latrine 2. Latrine with Shade 3. VIP latrine 4. Flush to sewage/septic tank 5. Other (specify)______________________	

128	What is your main source of drinking water for the household?	1. Piped into dwelling 2. Piped into yard, plot 3. Public tab/stand pipe 4. Protected well 5. Unprotected well 6. Protected Spring 7. Unprotected spring 8. Rain water 9. Surface water (river, stream, dam, lake, pond, irrigation channel) 10. Other (specify)________________	
129	How long does it take to fetch water? (get water and comeback)	_________ hours _________ minutes	
130	Who is mostly responsible for fetching water?	1. Yourself 2. Husband 3. Children 4. Maid 5. Other (specify)	

Part II: Maternal Health and Nutrition

NO.	QUESTIONS	RESPONSE OPTIONS (CODE)	SKIP
201	Did you suffer from any sickness in the last two weeks or currently?	0. No 1. Yes	→203
202	If yes for Q # 1, what were your sicknesses? (Please list everything the mother mentions)	________________________________ ________________________________ ________________________________ ________________________________	
203	What is your current Physiological status?	1. Pregnant 2. Lactating 3. Pregnant and lactating 4. Non pregnant Non lactating	
204	Where did you go for antenatal care for your last pregnancy?	1. I did not go anywhere 2. Government Hospital 3. Private Hospital 4. Health center 5. Govt. clinic 6. Private clinic 7. Health post 8. Other, specify____________________	→206

205	How many times did you attend antenatal care during your last pregnancy?	___________number of times.	
206	Did you take iron/folate during your last pregnancy?	0. No 1. Yes 2. Don't know	
207	Did you receive any nutrition and health message from the local HEW or VCHWs during your pregnancy or after delivery of (child name)?	0. No 1. Yes	→209
208	If 'Yes' for Q #7, on what area was the message you got? *(More than one answer is possible. Circle on the best options or write them on the space provided).*	1. On Exclusive breastfeeding 2. On Complementary Feeding 3. On Hygiene & Sanitation 4. On Family planning 5. On child caring practices 6. Other, specify ____________________ ______________________________ ___	
209	During your pregnancy, do you stop eating any food for cultural reasons?)	0. No 1. Yes	→211
210	If 'Yes' for Q #9, what foods do you stop eating and why?	______________________________ ______________________________ ______________________________ _____________	
211	During your last pregnancy, did you eat	1. As usual 2. less than usual 3. more than usual	
212	If you eat more than usual during your last pregnancy, why did you consume extra meal? (more than one answer is possible)	______________________________ ______________________________ ______________________________ ______________________________ _____	
213	If you eat less or the same as usual during your last pregnancy, what was the reason?	______________________________ ______________________________ ______________________________ ______________________________ ____________	

214	How was/is your food intake during your periods of lactation?	1. Less than normal 2. Same as normal 3. More than normal 4. Don't know	
215	If you increased intake during lactation, what was the reason?	__________________________________ __________________________________ __________________________________ __________________________________ _______	
216	If the mother consumed same as or less than usual during lactation, ask why?	__________________________________ ______ __________________________________ __________________________________ ______________________________	
217	Where did you give birth to (name youngest child)?	1. Own home 2. Parents' home 3. Government hospital/clinic/health center 4. Private hospital/clinic/health center 5. Other place (specify)________________ 6. Don't know	
218	Was (name) weighed immediately after birth?	0. No 1. Yes 2. Don't know	
219	Do you know what 'balanced diet' mean/what a 'varied diet mean?	0. No 1. Yes	
220	What are foods rich in iron? (More than one answer is possible)	1 Teff 2 Wheat 2. Barley 3. Pulses (chickpeas, lentil, beans) 4. Green vegetables 5. Vegetables, fruits 6. Fish, meat, poultry 7. Diary (butter, milk, cheese, yoghurt) 8. Fats and oils 9. Salt 10. Other (specify)___________ 11. Don't know	

Part III: Youngest Child Nutrition (Child feeding practices)

[Note: This section is to be administered only to mother with a live birth in the 2 years (0-23.9 months) preceding the date of interview. Use pencil and write the name of the youngest child under age 2 years here__________ and use this name where indicated in the following questions below.]

No	**Questions**	**Response options (Coding)**	**Skip**
301	What is the sex of the youngest child (Name)?	1.Female 2.Male	
302	Child date of birth? (from immunization card)	_______________	
303	Did you ever breastfeed (Name of child)?	0. No 1. Yes	→305
304	If 'no', why (Name) was not breastfeed?	_________________________	
305	How long after birth did you first put (Name) to the breast?	1. Immediately 2. One to twenty-four hours 3. More than 24 hours 4. Don't know/remember	
306	What did you do with the 'first milk' (Colostrum)? [Colostrum is the first yellowish milk or '*Inger*']	1.Gave to the baby 2.Discarded it	
307	In the first 3 days after delivery, was (name) given anything to drink other than breast milk?	0. No 1. Yes	→309
308	What was (Name) given to drink? (More than one answer is possible)	1. Milk (other than breast milk) 2. Plain water 3. Sugar or glucose water 4. Fruit juice 5. Infant formula 6. Tea/infusion 7. Honey 8. Raw butter 9. Fenugreek water (*Abish* water) 10. Other (specify)____________	
309	For how long did you give the child breast milk only (exclusively breastfed)?	______________ Months.	
310	Is (Name) still being breastfed?	0. No 1. Yes	→312
311	How many times did you breastfeed (Name) yesterday day and night? [How many times from morning to sunset? _____ How many times from sunset to sunrise? _______	____________ Number of times.	

	If the answer is not in number, probe for approximate number and sum the two, then write the total.]		
312	If you stopped breastfeeding, how long did you breastfeed (Name)?	In days ________ In months _______	
313	Since this time yesterday, how many times did (name) eat solid, semisolid, or soft foods other than liquids?	1. Once 2. Twice 3. Three times 4. Four times 5. Other (specify)__________ 6. Don't know	
314	What age did you first give solid or semi-solid food to (name)?	When (Name) was _______ months old.	
315	Has (name) been sick in the past two weeks?	0. No 1. Yes	
316	If 'Yes'/child has been sick, ask mother to specify what the sicknesses were	___________________________ ___________________________	

Part IV: Questions related to pulse production and consumption

No	Questions	Response items (coding)	Skip
401	Do you grow any pulse crops? *Probe: chickpeas, pea, lentils, haricot bean, faba beans and the like*	0. No 1. Yes	→406
402.	What pulses do you grow? *Probe for common pulses and list as many as possible [pulses include: peas, chickpeas, lentils, faba beans, haricot beans, kidney beans and others]*	________________________________ ________________________________ ________________________________ ________________________________	
403	How much did you harvest in your last harvesting season? *[Encourage respondent to provide an estimate of the amount of produce for pulses in quintal or 'madaberiya']*	_______*quintals* _______ *Madaberiya (______kg)*	
404	What do you do with the produce?	1. Sell it at the local market 2. Use if for household consumption 3. Both for market and household consumption 4. Other (specify)__________________________	

405	Who is mainly in charge of pulse production in your community, men or women or both?	1. Men 2. Women 3. Both 4. Don't know	
406	Do you have access to your own piece of land where you grow some crops?	0. No 1. Yes	→408
407	What do you grow in your piece of land? *[probe to include everything the mother grows in her land]*	______________________________ ______________________________	
408	Do you consume any pulses or food made from pulses for yourself and for (Name of child)?	0. No 1. Yes	
409	If mother replied 'No' for Q #408, ask 'why?'	1. We produce only for market purpose 2. We don't produce enough for both consumption and for market 3. It takes a lot of time to prepare food from pulses 4. Consumes a lot of fire wood. 5. Problem with flatulence/bloating. 6. Other, (specify) __________________ ______________________________ ___	
410	Where do you mostly get your supply of pulses for household consumption?	1.- Own production 2. Purchase from market 3. Food aid 4. Own production and purchase 5. Other, specify ________________ ____________________________	
411	What are the most common foods you prepare from pulses? Which pulses are most commonly used to make meals? *[write everything the mother mentions and probe for more]*	______________________________ _ ______________________________ _ ______________________________ __	
412	How do you eat pulses/foods made from pulses or what other food items do you eat pulses with?	______________________________ ___ ______________________________ ___ ______________________________ ___ ______________________________	

413	What is your attitude toward the consumption of pulses or foods made from pulses	1. Like 2. Dislike it 3. Not like it much but eat it anyway 4. Don't know 5. Other, (specify) ________________	
414	Do you know any nutritional benefit of eating pulses compared to other cereals?	0. No 1. Yes	→415
415	Can you tell me some of the nutritional benefits of pulses? [probe and write as many as the mother can mention]	________________ ________________ ________________ ________________	
416	Now or in the future, do you currently intend to eat more pulses (foods made from pulses) for yourself and young children?	0. No 1. Yes	
417	For Q # 15, ask why or why not?	________________ ________________ ________________	
418	What are your major challenges with regard to production of pulse crops [why can't you produce/produce more?]	1. Poor soil infertility and productivity 2. Lack of farm input [artificial fertilizer, improved seed] 3. Lack of water source/dependence on rain 4. Don't have good market access to sell produce 5. Other, specify ________________	
419	Does your household or you currently have any intention/plan to produce more pulses in the future?	0. No 1. Yes	
420	For Q # 419, ask why or why not?	________________	

Questions on the constructs of the Health Belief Model

To what extent do you agree with the following statements? Please answer honestly and circle on the right option.

No.	Question *(Key: 421-23=susceptibility; 424-26=severity; 427-29 =benefit; 430-32=barriers; 433-35 =cues for action; 436-38=self-efficacy)*	Response options (coding)				
		Strongly disagree	**Disagree**	**Not sure**	**Agree**	**Strongly agree**

421	If I eat *less than usual* during pregnancy and lactation, I may become malnourished.	1	2	3	4	5
422	If my child and I continue without changing what we are currently eating, both my child and myself may become malnourished sooner or later.	1	2	3	4	5
423	Not eating more than usual during pregnancy will help me to have small (light weight) baby at birth and hence, not eating more than usual during pregnancy is a good practice.	1	2	3	4	5
424	I am scared of giving birth to a small sized baby because I did not eat well during pregnancy.	1	2	3	4	5
425	Not eating from varieties of food groups (including pulses) during pregnancy and lactation may severely affect my health and my child's health	1	2	3	4	5
426	If my child is malnourished at early years (0-5 years), it doesn't bother me a lot because he/she will well when grown up.	1	2	3	4	5
427	If my child and I regularly eat pulses along with cereals and other foods, our nutritional health will be good even if we are not eating meat and meat products.	1	2	3	4	5
428	I believe pulses (like beans, lentil, chickpea, pea) are good sources of protein and other important micronutrients beneficial to my and my child's nutritional health.	1	2	3	4	5
429	Pulses crops are not only good for my and my child's nutrition but also for increasing the productivity of our farm, our household income and food security.	1	2	3	4	5

430	I don’t believe eating pulses is that much beneficial for me and my child’s nutritional health.	1	2	3	4	5
431	Eating pulses often is boring and pulses are foods only for poor people (e.g. people we cannot afford animal source foods).	1	2	3	4	5
432	Pulses are not cheap and preparing them is time consuming and they are not good for our stomach (e.g. flatulence) so I don’t think I will eat more pulses in the future.	1	2	3	4	5
433	We produce pulses for household consumption and for market	1	2	3	4	5
434	Even if we don’t grow a lot of pulses crops, we will plan to produce/purchase more in the future for household consumption.	1	2	3	4	5
435	I usually get nutrition education on the important roles of pulses in my diet from local nutrition educators.	1	2	3	4	5
436	If different food is available at home, I know how to prepare balanced diet by including variety of foods in a meal.	1	2	3	4	5
437	I know how to prepare different foods from pulse crops by cooking them together other foods to increase their protein quality.	1	2	3	4	5
438	I have a better understanding of how I should eat during pregnancy and lactation for the benefit of both my and my child’s health.	1	2	3	4	5

Part V: Household (HH) Food Security (Introductory)

501	How many times do you cultivate within a year?	1.Yearly 2.Biannual 3.Three-times	

502	What % of your main food source is from…?	1. Own production _____% 2. Purchase ______% 3. Food aid/donation_____% 4. Other (specify) _______%	
503	If your source of staple food is purchase; what is the income source? *(More than one answer is possible).*	1. Salary/ wage 2. Own business 3. Sale of livestock 4. Remittance 5. Other/specify	
504	Have you or your HH been involved in any food security program in the 'Woreda'?	0. No 1. Yes	
505	If 'yes' for Q #4, in which of the following food security programs has your HH been involved?	1. Productive safety net package program (PSNP) 2. Enhanced outreach strategy for under 5 children 3. Relief 4. Income generation activities 5. Others, specify_________________________	
506	How long does your food store usually last after harvest?	1. Less than two months 2. Two to four months 3. Five to eight months 4. Nine to twelve months	

Part VI: Food Security (Main items)

No	**Question**	**Response options (coding)**	**Skip**
601	In the past four weeks, did you worry that your household would not have enough food?	0. No 1.Yes	→602
601.a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
602	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0. No 1. Yes	→603
	How often did this happen?	1.Rarely (once or twice in the past four weeks)	

602.a		2.Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
603	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0. No 1. Yes	→604
603.a	How often did this happen?	1.Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
604	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0. No 1.Yes	→605
604.a	How often did this happen?	1.Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
605	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0. No 1.Yes	→606
605.a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
606	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0. No 1.Yes	→607

606.a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3.Often (more than ten times in the past four weeks)	
607	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0. No 1.Yes	→608
607.a	How often did this happen?	1. Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	
608	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0. No 1.Yes	→609
608.a	How often did this happen?	1.Rarely (once or twice in the past four weeks) 2.Sometimes (three to ten times in the past four weeks) 3.Often (more than ten times in the past four weeks)	
609	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0. No (pass to the next section) 1.Yes	
609.a	How often did this happen?	1.Rarely (once or twice in the past four weeks) 2. Sometimes (three to ten times in the past four weeks) 3. Often (more than ten times in the past four weeks)	

Part VII: Food Frequency Questionnaire

No	Food Items	How often do you consume the following food items or their product? Indicate with a checkmark (✓) the category that best describes the average frequency with which you consume the particular food item.						Remark
		>Once per day	Once per day	3-6 per week	Once or twice per week	Twice per month or less	Never	
701	Pulses or foods made from them							
701.1	Lentil							
701.2	Chickpea							
701.3	Peas							
701.4	Haricot Beans							
701.5	Kidney bean							
701.6	Horse beans (faba bean)							
701.7	Others, such as pigeon pea, grass pea							
702	Meat/poultry/fish/dairy							
702.1	Any meat							
702.2	Any poultry							
702.3	Any fish							
702.4	Any dairy (e.g. milk. Yogurt, cheese)							
703	Fruits and Vegetables							
703.1	Any fruits (e.g. banana, orange, lemon, papaya, pine apple, avocado and guava)							
703.2	Any vegetables (e.g. kale, cabbage, lettuce)							

Part VIII: Dietary Diversity Questionnaire

Dietary diversity Score (DDS)

Please describe the foods (meals & sancks) that you and your child ate or drank yesterday during the day and night, whether at home or outside the home. Start with the first food or drink of the morning.

Write down all food and drinks mentioned. When composite dishes are mentioned ask for the list of ingredients.When the respondent has finished, probe for meals and snaks not mentioned.

	Breakfast	Snack	Lunch	Snack	Dinner	Snack
Mother						
Child						

When the respondent recall is complete, fill in the food groups based on the information recorded above. For any food groups not mentioned, ask the respondent if a food item from this group was consumed.

Include in bracket the specific food item the individual consumed under the 'Yes/No' column.

Question Number	Food group	Examples	No=0 Yes=1 Mother	No= 0 Yes=1 Child
801	Cereals	Corn/maize, rice, wheat, sorghum, millet or any other grains or foods made from these (e.g. bread, noodles, porridge or other grain products) + insert local foods e.g. ugali, nshima, porridge or paste		

802	White roots and tubers	White potatoes, white yam, white cassava, or other foods made from roots		
803	Vitamin A rich vegetables and tubers	Pumpkin, carrot, squash, or sweet potato that are orange inside + other locally available vitain A rich vegetables (e.g. red sweet pepper)		
804	Dark green leafy vegetables	Dark green leafy vegetables, including wild forms + *locally available vitamin A rich leaves such as amaranth, cassava leaves, kale, spinach*		
805	Other vegetables	other vegetables (e.g. tomato, onion, eggplant) + *other locally available vegetables*		
806	Vitamin A rich fruits	ripe mango, cantaloupe, apricot (fresh or dried), ripe papaya, dried peach, and 100% fruit juice made from these + *other locally available vitamin A rich fruit*		
807	Other fruits	other fruits, including wild fruits and 100% fruit juice made from these		
808	Organ meat	Liver, kidney, heart or other organ meats or blood-based food		
809	Flesh meats	Beef, pork, lambs, goat, rabbit, game, chicken, duck, other birds, insects		
810	Eggs	Eggs from chicken, duck , guinea fowl or any other egg		
811	Fish and seafood	Fresh or dried fish or shellfish		
812	Legumes, nuts and seeds	Dried beans, dried peas, lentils, nuts seeds or foods made from these (e.g. hummus, peanut butter)		
813	Milk and milk products	Milk, cheese, yogurt or other milk products		
814	Oils and fats	Oil, fats or butter added to food or used for cooking		
815	Sweets	Sugar, honey, sweetend soda or sweetend juice drink, sugary foods such as chocolates, candies, cookies and cakes		
816	Spices, condiment, beverages	Spices (black pepper, salt) condiments (soy sauce, hot sauce), coffee, tea, alcoholic beverages		
Individual level	Did you eat anything (meal or snack) OUTSIDE the home yesterday? How about (Name of child)?			

Thank you for your participation!

Participant's code: _______________ Date of measurement: ____________

Part IX: Anthropometry

Child's date of birth *(from immunization card):* _____________**:** Child's age**:** ______ months

No.	Body part to be measured	Measurement for MOTHER	Measurement for CHILD
1	Weight (in Kg) Please measure to the nearest 10g for infants and 0.1kg for older children and adults. Take third measurement if difference in the first two exceeds 5g and 0.05kg, respectively.	1st_____________ 2nd_____________ 3rd_____________ Average________	1st_____________ 2nd_____________ 3rd_____________ Average________
2	Height (in cm) Please measure to the nearest 0.1. Take the 3rd measurement if difference between the first two exceeds 0.5cm	1st_____________ 2nd_____________ 3rd_____________ Average________	1st_____________ 2nd_____________ 3rd_____________ Average________
3	Mid-upper-arm-circumference (MUAC) (in cm) Please measure to the nearest 0.1cm. Take the 3rd measurement if difference between the first two exceeds 0.5cm	1st_____________ 2nd_____________ 3rd_____________ Average________	1st_____________ 2nd_____________ 3rd_____________ Average________
4	<u>FOR CHILD ONLY:</u> Head circumference (HC) (in cm) Please measure to the nearest 0.1. Take the 3rd measurement if difference between the first two exceeds 0.5cm		1st_____________ 2nd_____________ 3rd_____________ Average________
5	Triceps skinfold (in mm) Please measure to the nearest 0.1. Take the 3rd measurement if difference between the first two exceeds 0.9mm		1st_____________ 2nd_____________ 3rd_____________ Average________

Thank you for your participation

Part X: Weighed Food Record Form

Please fill out all foods and drinks the mother or the child consumes in the appropriate column with description of the food and cooking method**.**

Name of observer: ________________ Scale no: ___________________ Observation date: _______________				Kebele: _______________ Participant's code: __________ Mother ☐ Child ☐		
Time	Place	Food/Drink	Description & cooking method	Amount served (g)	Amount left (g)	Amount eaten (g)

Thank you for your participation!

Recipe form for mixed dish

Participant's Code: _______________Name of the mixed Dish: _________________________ If child, indicate Sex: Male ☐ Female ☐

Please list and describe all ingredients of the recipe, amount in HH measures and the weight equivalent, final weight of the cooked dish and the proportion consumed by participants.

Ingredient	Description of ingredient and cooking method	Amount of raw ingredient in recipe	Wt. of raw ingredient in recipe (g)	Wt. of raw ingredients consumed (g)	Wt. of cooked ingredient in recipe (g)	Proportion of cooked ingredient in mixed food	Wt. of cooked ingredient consumed (g)

Wt. of empty pot ________ (g); Total Wt. of pot with cooked mixed recipe _______ (g);

Total Wt. of mixed food _________ (g); amount consumed

by participant ________ (g)

Name of community: _________________
Date of Discussion: _________________

D. Interview Guide for Focus Group Discussion and Key Informant Interview

Part XI: Interview Guide for Focus Group Discussion (FGD) participants and key-informants on pulse and other crops production, consumption, challenges and benefits associated with them.

Instruction for Facilitator:

- ❖ Greet participants in culturally accepted manner and introduce the objective of the FGD/interview.
- ❖ Encourage and assure participants that they can freely speak out on any issues related to the FDG/interview
- ❖ Alert participants that your role will be only to guide and facilitate the group's discussion;
- ❖ Have a note taker who should document exchange of the views and the content of the discussion and who should also carefully note comments made by particular individuals.
- ❖ Allow participants to brainstorm some common ground rules for the FGD and include the following:
    - Everyone should participate
    - Information provided in focus group must be kept confidential
    - Stay with the group and please don't have side conversations
- ❖ Ask the group if there are any questions before we get started and address those question
- ❖ Start asking guiding question

1. What are the most common crops produced in this area?
2. A. Please mention the most commonly grown pulses, if any, in your area and
   B. For what purpose do you normally grow pulses? [Clue: own consumption, for market purpose, both?]

3. Can you discuss the challenges in the production of pulse crops in your area?
4. What do you think are the benefits of pulse production? [Encourage participants to mention everything they know about pulse crops.]
5. Consider the practice of many years of crop production in your area: has it changed from what it used to be in the past?

A. *Example*: Is there a crop you no longer produce or produce less compared to what it was in the past? Why?

B. If there is any change in the crop production practice of the area, what was/is causing it?

6. What is your attitude towards foods made from pulses? [What pulse foods are commonly eaten in your community & do you like them? Why or why not?]

7. Do you plan or intend to utilize a bit more of your crop land to produce more pulse in the future? Why or why not?

Appendix F: Consent forms

UNIVERSITY OF SASKATCHEWAN

College of Pharmacy and Nutrition

110 Science Place, Saskatoon SK
S7N 5C9 Canada
Telephone: (306) 966-6327
Facsimile: (306) 966-6377
Web Site: http://www.usask.ca/pharmacy-nutrition/

Participant Consent Form (Mothers)

Project Title: Dietary practices, maternal nutritional status and child stunting: A comparative study in pulse growing and non-pulse growing rural communities in Southern Ethiopia

Researcher(s): Getahun Lombamo, a Ph.D. Graduate student, College of Pharmacy and Nutrition, University of Saskatchewan; Email: gel391@mail.usask.ca [Cellphone in Ethiopia: +251912444433]

Supervisor: Gordon A. Zello, Ph.D., Division Head and Professor of Nutrition and Dietetics, College of Pharmacy and Nutrition, University of Saskatchewan; Phone: (306) 966-5825; Email: gaz511@campus.usask.ca

Introduction:

Dear,

You are being asked to be part of a research study that is being conducted in your community. You are contacted because you are a mother and have a child under the age of five years. You are free to ask anything you would like to know about the research, data collectors and the researcher. Member of the research group will explain you about the study before you would be asked for your verbal agreement (oral consent).

Purpose of the Research:

- The purpose of the study is to assess the nutritional health of mothers and their young children in your community as compared to other communities that may have different dietary habits. This will be helpful to improve maternal and child nutrition, and health services in your community and in other similar rural communities.

Procedures (What you will be asked to do when you participate in the study**):**

- You will be asked to sit with a data collector at your residence for about 90 minutes and be interviewed on the general conditions and food security situations of your household, yours and your child's health and dietary habits.
- With your permission, a local research assistant will come and stay by your house from morning to evening to measure all foods you and your child would consume in a particular day. However, on this day you are to continue with your daily routine and shouldn't change your eating habit as this may affects the study.
- You will also be asked to allow us measure your weight, height and mid-upper arm circumference and also your child's weight, length/height, mid-upper arm and head circumferences, and triceps skinfold. These measurements and the interview will help us to examine yours and your child's nutritional health and factors affecting it. The body measurements will take place at a central location convenient to you and most of the other mothers participating in the study. This will be done on a separate day and the local community health worker will inform you the specific day.
- We would want to kindly request you to recollect all the data after a period of 6-8 months. This study will take place in two other similar communities and over a 100 mother-child pairs are anticipated to participate

in each community. Between the initial and final data collection period, you may be invited to come out along with other community members and discuss on some of the nutrition concerns in your community.

- Please feel free to ask any questions regarding the procedures and goals of the study or your role.

Funded by:

- This study is supported by partly by IDRC (International Development Research Center) and partly by AUCC (Association of Universities and Colleges of Canada)

Potential Risks:

- There are no known or anticipated risks to you by participating in this research

Potential Benefits:

- The outcome of the study will be shared to the local health offices and be used to inform/improve nutrition and health services being offered to mothers and small children in your communities. It will also help to inform future nutrition intervention projects in your society.

Confidentiality:

- All the information we will collect from you will be kept strictly confidential. Although the data from this research project will be published and presented at conferences, the data will be reported in aggregate form, so that it will not be possible to identify individuals.
- **Storage of Data:**
  Consent forms, filled questionnaires, anthropometric dietary forms will be kept in a locked room with the student's supervisor for about five years until findings are published and shared relevant bodies. When the data are no longer required, it will be destroyed safely.

Right to Withdraw:

- Your participation is voluntary and you can answer only those questions that you are comfortable with. You may withdraw from the research project for any reason, at any time without explanation or penalty of any sort.
- Your right to withdraw data from the study will apply until data have been pooled. After this point, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data.

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1;
- This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

Consent (Oral)

- Do you have any questions regarding your participation in the study? Are you willing to participate in this study? Yes ☐ No ☐
- I read and explained this Consent Form to the participant before receiving the participant's consent, and the participant had knowledge of its contents and appeared to understand it.

______________________	______________________	______________
Name of Participant	*Researcher's Signature*	*Date*

UNIVERSITY OF SASKATCHEWAN

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S7N 5C9 Canada
Telephone: (306) 966-6327
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Web Site: http://www.usask.ca/pharmacy-nutrition/

Participant Consent Form (Farmers & Key Informants)

Project Title: Dietary practices, maternal nutritional status and child stunting: A comparative study in pulse growing and non-pulse growing rural communities in Southern Ethiopia

Researcher(s): Getahun Lombamo, a Ph.D. Graduate Student, College of Pharmacy and Nutrition, University of Saskatchewan; Email: gel391@mail.usask.ca [Cellphone in Ethiopia: +251912444433]

Supervisor: Gordon A. Zello, Ph.D., Division Head and Professor of Nutrition and Dietetics, College of Pharmacy and Nutrition, University of Saskatchewan; Phone: (306) 966-5825; Email: gaz511@campus.usask.ca

Introduction:

Dear,

You are being asked to be part of a research study that is being conducted in your community. We are currently working with mothers and children in your community with the goal of seeking ways to improve their nutritional health. As part of the study, we also want to hear from experienced farmers/expert like you about factors affecting some of the agricultural practices in your community, as it relates to food and nutrition. You may ask anything you would like to know about the research, data collectors and the researcher. Below, we will explain you about the study before we ask for your voluntary participation in a Focus Group Discussion (FGD) [or individual interview, if you are a local agriculture expert].

Purpose of the Research:

- The purpose of the study is to assess the nutritional health of mothers and their young children in your community as compared to other communities that may have different dietary habits. This will be helpful to improve maternal and child nutrition, and health services in your community and in other similar rural communities.
- The Focus Group Discussion will bring additional insight on factors affecting food production, especially pulses and how that relates to nutritional health in your community.

Procedures (What you will be asked to do when you participate in the study**):**

- You will be asked to sit with the researcher and members of the research team to share your thought some of the factors affecting food production and how it relates to nutrition in your community.
- For this discussion, which might take about an hour, you will sit with 7-10 other farmers from your community.
- The researcher may record the discussion/interview with voice recorder to better capture the issues discussed.
- If deemed necessary, this discussion maybe repeated after months and we may ask your permission again.
- In some situations, a photo of the group may be taken during the discussion for documentation. In these cases, your permission will be requested prior to taking the pictures with a separate consent form
- Please feel free to ask any questions regarding the procedures and goals of the study or your role.

Funded by:

- This study is supported by partly by IDRC (International Development Research Center) and partly by AUCC (Association of Universities and Colleges of Canada)

Potential Risks:

- There are no known or anticipated risks to you by participating in this research

Potential Benefits:

- The outcome of the study will be shared to the local health offices and be used to inform/improve nutrition and health services being offered to mothers and small children in your communities. It will also help to inform future nutrition intervention projects in your society.

Confidentiality:

- All the information we will collect from you will be kept strictly confidential. Although the data from this research project will be published and presented at conferences, the data will be reported in aggregate form, or in case a direct quotation has be used, personally identifying information will be removed so that it will not be possible to identify individuals.
- You will also be given a chance to verify/modify the content of the discussion before it is reported.
- The researcher will undertake to safeguard the confidentiality of the discussion, but cannot guarantee that other members of the group will do so. Please respect the confidentiality of the other members of the group by not disclosing the contents of this discussion outside the group, and be aware that others may not respect your confidentiality.

- **Storage of Data:**
  Consent forms and the FGD notes will be kept in a locked room with the student's supervisor for about five years until findings are published and shared relevant bodies. All electronic files will be stored a password protected computer with the researcher. When the data are no longer required, it will be destroyed safely.

Right to Withdraw:

- Your participation is voluntary and you can answer only those questions that you are comfortable with. You may withdraw from the research project for any reason, at any time without explanation or penalty of any sort.
- Your right to withdraw data from the study will apply until data have been pooled. After this point, it is possible that some form of research dissemination will have already occurred and it may not be possible to withdraw your data.

Questions or Concerns:

- Contact the researcher(s) using the information at the top of page 1;
- This research project has been approved on ethical grounds by the University of Saskatchewan Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Research Ethics Office ethics.office@usask.ca (306) 966-2975. Out of town participants may call toll free (888) 966-2975.

Consent (Oral)

- Do you have any questions regarding your participation in the study? Are you willing to participate in this study? Yes ☐ No ☐
- I read and explained this Consent Form to the participant before receiving the participant's consent, and the participant had knowledge of its contents and appeared to understand it.

Name of Participant	*Researcher's Signature*	*Date*

Appendix G: Other forms (photo consent and transcript release)

College of Pharmacy and Nutrition
110 Science Place, Saskatoon SK
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UNIVERSITY OF SASKATCHEWAN

Photo Consent Form

Please read, complete and sign/date below.

I, ______________________________, hereby give permission to researchers from the College of Pharmacy and
(Your name – please print legibly)
Nutrition, University of Saskatchewan, to photograph/film me. I grant the College of Pharmacy and Nutrition, University of Saskatchewan, the right to use, publish and display or permit the use, publication and display of audio-visual or digital recordings, or other electronic images of me (collectively, "**my Photographs**") at their sole discretion in any publication in connection with activities relating to the educational purpose of the College and/or the University.

Oral Consent

I read and explained this Consent Form to the participant before receiving the participant's consent before taking their picture, and the participant had knowledge the use of their picture as described and gave their verbal agreement.

______________________	______________________	______________
Name of Participant	*Researcher's Signature*	*Date*

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Transcript Release Consent Form
(Farmers in the Focus Group Discussion)

I ________________________________, have been given the opportunity to listen to the complete transcript of the Focus Group Discussion I participated in this study, and have been provided with the opportunity to add, alter, and delete information from the transcript as appropriate. I acknowledge that the transcript accurately reflects what I said during the discussion, along with other farmers, with Getahun Lombamo. I hereby authorize the release of this transcript to Getahun Lombamo to be used in the manner described in the Consent Form. I have received a copy of this Data/Transcript Release Form for my own records.

Oral Consent

I read and explained this Consent Form to the participant before receiving the participant's consent, and the participant had knowledge of its contents and appeared to understand it.

______________________________	______________________________	________________
Name of Participant	*Researcher's Signature*	*Date*